BIOLOGICAL DRAWINGS

WITH NOTES

By MAUD JEPSON, M.Sc. (Manchester)
(First Class Honours in Zoology)

With a Preface by
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PART I

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To the Memory of my Mother
EMILYNE MAUD JEPSON

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PREFACE

THE considerable experience gained by Miss Jepson in teaching School Certificate pupils and candidates for higher examinations, has prompted her to produce this book of illustrations. Her object has been, not to minimize or cut out much of the practical work, but rather to enable the student to derive the greatest benefit from a period in the laboratory, which is always too short in the average school curriculum, and usually so even in the University. In both Botany and Zoology the execution of practical work is often long and difficult, but the time taken can be cut down, and the value derived from the dissection or preparation increased enormously when the student, by the aid of a well-labelled drawing, can see what to look for. Miss Jepson's work collects together, in a convenient form, actual drawings of her own preparations, which are realistic and not diagrammatic.

A criticism often levelled against the production of such drawings is that it provides the lazy pupil with something that can be copied, and the actual dissection maybe done not at all. This is admittedly so, but pupils of that level will always be with us, from the preparatory school up to the post-graduate. They cannot and should not be considered. In any case, these drawings of Miss Jepson's, taken as they are from actual dissections, would be difficult to memorize. They are not diagrams which can be remembered easily in a perfectly unintelligent manner. They provide simple drawings which the good student can have by him when he is carrying out his practical work, and by their excellence, provide him with a clear-cut key to the structures and arrangements he is expected to find in his practical work.

H. GRAHAM CANNON.

ACKNOWLEDGMENTS

THE completion of this work would not have been possible, had it not been for the kindness which I have received from many people.

My thanks are due to my friend Miss Elsie I. MacGill, M.Sc., and to my former Lecturer, Mr. W. O. Howarth, D.Sc., both of the Manchester University, for the time which they have so generously given in going through the first rough sketches, and later the finished drawings. Their suggestions and criticisms have been most valuable in the arrangement of this work.

I wish to thank Professor Graham Cannon, Sc.D., F.R.S., for writing the Preface, and also for the kindness he has shown, and the encouragement he has given me, in his criticism of the drawings.

I should like to record my indebtedness to Mr. Heasman, H.M.I., and Mr. Painter, H.M.I., for their helpful suggestions with regard to the publication of these volumes.

I express my gratitude to the Head Master, Mr. M. J. H. Cooke, M.Sc., in whose laboratory much preparation and practical work has been done, and to Mr. George Wood, M.Sc., Principal of the Stockport College for Further Education, whose interest in my drawing and teaching of the subject has been the source of constant encouragement, and also to Mr. Kendell for much advice with regard to the reproduction of such work.

Finally, I should like to thank the publishers for their courtesy and consideration at all times.

MAUD JEPSON.

May, 1938

For whatever improvements are to be found in this second edition I must again thank Miss Elsie I. MacGill and Dr. W. O. Howarth.

To Professor Graham Cannon I am much indebted for his valuable help and advice.

MAUD JEPSON.

February, 1939

CLASSIFICATION OF FRUITS

- **True fruits**
  - **Dry**
    - **Dehiscent**
      - **One carpel**
        - **FOLLICLES** — Delphinium, Columbine, Monkshood, Marsh Marigold etc.
        - **LEGUMES** — Laburnum, Bean, Pea, Lupin etc.
      - **Two carpels**
        - **SILIQUAS** — Stock, Wallflower
        - **SILICULAS** — Honesty, Candytuft, Shepherd's Purse etc.
      - **Two or more carpels.**
        - **CAPSULES** — Poppy, Campanula, Snapdragon, Horse chestnut, Campion, Evening Primrose, Violet, Scarlet Pimpernel
    - **Indehiscent**
      - **One carpel**
        - **NUTS or ACHENES** — Acorn, Oak, Sweet chestnut, Beech, Rose, Strawberry, Hornbeam, Samara of Ash, Elm.
      - **Two or more carpels**
        - **SCHIZOCARPS**
          - Double Samara of Sycamore etc.
          - Carcerulus of Mallow, Hollyhock, Hound's Tongue.
          - Cremocarp of Hogweed, Goutweed etc.
          - Lomentum of Bird's foot Trefoil etc.
  - **Succulent (Indehiscent)**
    - **One carpel [hard endocarp]**
      - **DRUPES** — Plum, Cherry, Blackberry (collection of drupes), Coconut (fibrous exocarp)
    - **Two or more carpels.**
      - **BERRIES.** — Date (One seed), Orange, Gooseberry, Banana, Marrow

FALSE FRUITS OR PSEUDOCARPS.

False fruits are formed when some part other than the ovary wall develops as a result of fertilisation. e.g. receptacle, inflorescence.

Receptacle:- Strawberry (achenes), Rose hip. ("), Apple.

Inflorescence:- Mulberry (achenes), Pineapple, Fig (drupes).

DISPERSAL OF FRUITS, SEEDS AND SPORES.

1. **WIND.**
   a) Small seeds and spores.
   b) Censer-mechanism e.g. Poppy.
   c) Increase in surface - with little increase in weight.
      (i) Seed parachutes e.g. Cotton
      (ii) Fruit parachutes. e.g. Dandelion.
      (iii) Winged seeds e.g. Pine.
      (iv) Winged fruits. e.g. Sycamore.
   d) Separation of carpels. e.g. Goutweed.
   e) Rolling of spheroidal fruits and seeds.

2. **WATER**
   a) Spongy aril in Water Lily
   b) Fibrous exocarp in Coconut.

3. **ANIMALS**
   a) Birds - Succulent seeds and fruits - false fruits.
   b) Mammals (i) Hooked fruits and seeds.
      (ii) Nuts etc. (Rodents only)
   c) Ants - Oily seeds. e.g. Gorse.
   d) Human traffic - e.g. shipping, forestry, wool manufacture etc.

4. **PROPULSIVE OR EXPLOSIVE MECHANISM.** - Here the construction of the fruit renders it independent of any of the above agencies.
   a) Tensions set up by the unequal drying of the pericarp e.g. Gorse, Violet, Geranium etc.
   b) (i) The turgidity of the pericarp e.g. Balsam.
      (ii) The turgidity of the aril e.g. Wood Sorrel.

M.W.M.J.

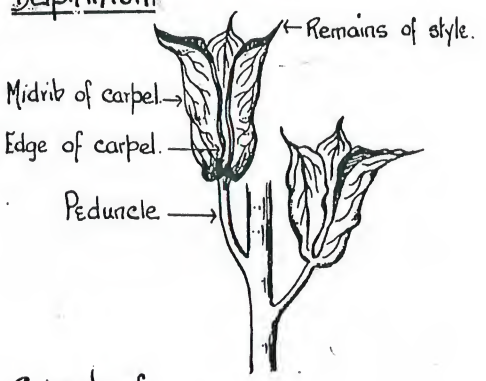
DISPERSAL OF FRUITS, SEEDS AND SPORES.

AGENTS :- WIND - WATER - ANIMALS - EXPLOSIVE OR PROPULSIVE MECHANISM

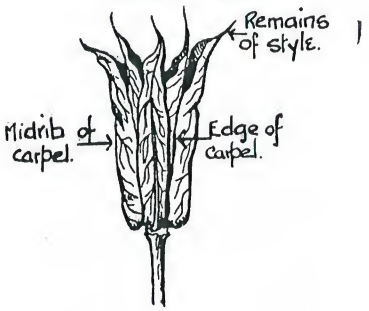
WIND a) Small spores - e.g. Fern, Fungi etc
Minute seeds, forming a powdery mass - In Orchid, a loose outer cover renders the seed more buoyant.

b) Censer - mechanism.

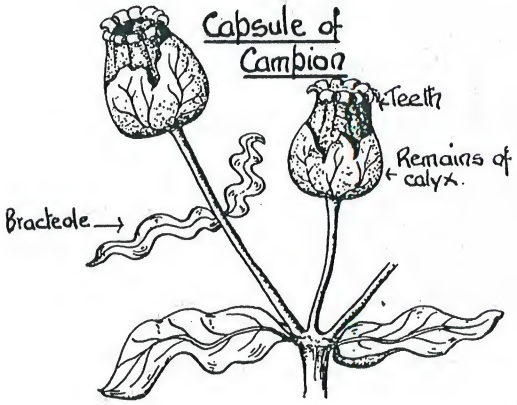
Follicles of Delphinium



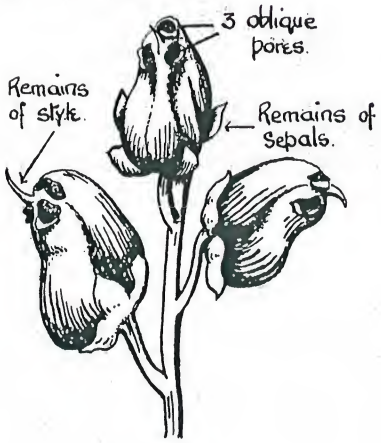
Follicles of Columbine.



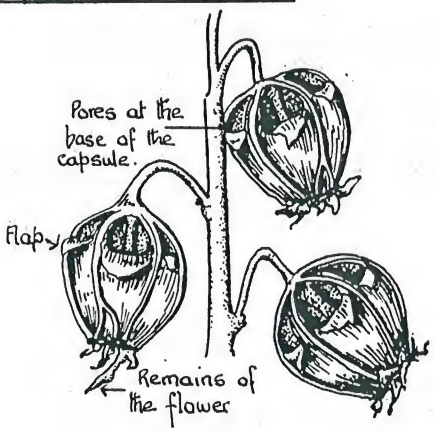
Capsule of Campion



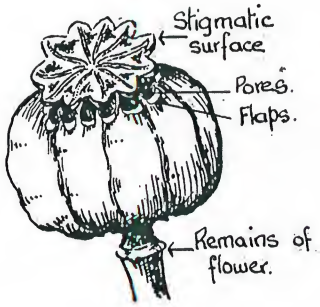
Capsule of Snapdragon.



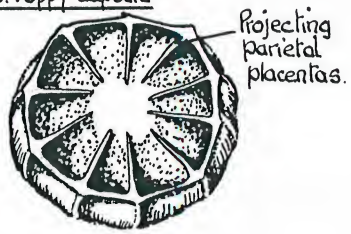
Capsule of Campanula.



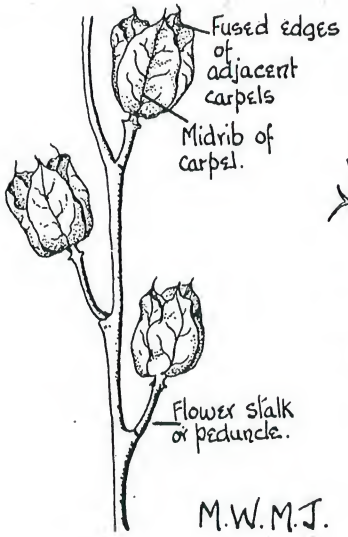
Capsule of Poppy.



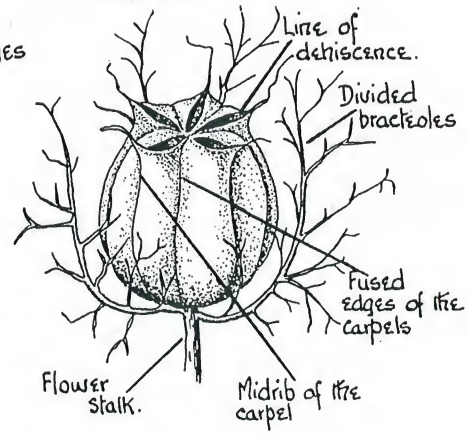
T.S. Poppy Capsule



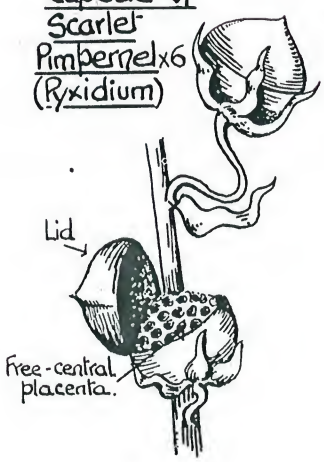
Capsule of Bluebell



Capsule of Nigella.



Capsule of Scarlet Pimpernel x6 (Pyxidium)



Capsule of Iris

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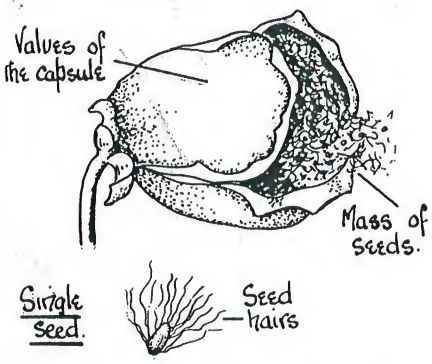
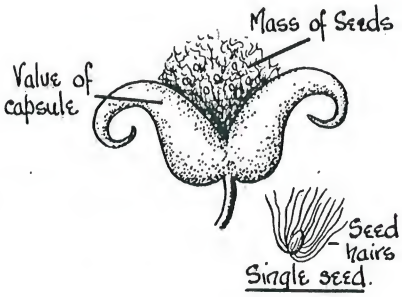
WIND. (continued) c) Increase in surface – Weight much the same.

1. Seed parachutes

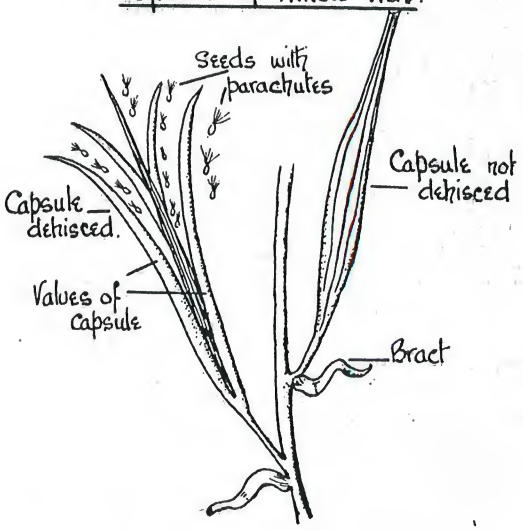
Capsule of Cotton.



Capsule of Willow x6

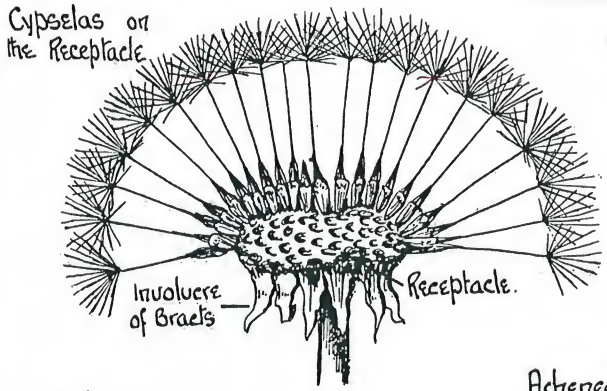


Capsule of Willow Herb.

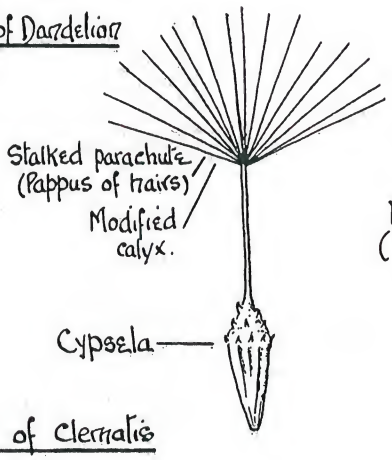


2. Fruit parachutes.

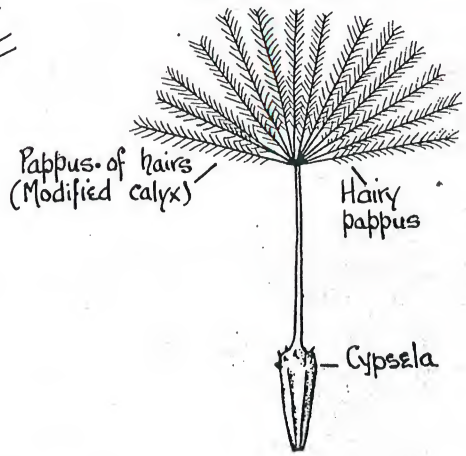
Dandelion (Cypsela)



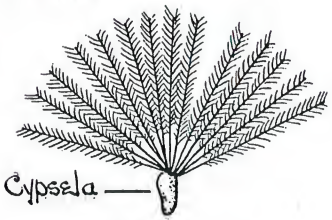
Cypselas of Dandelion



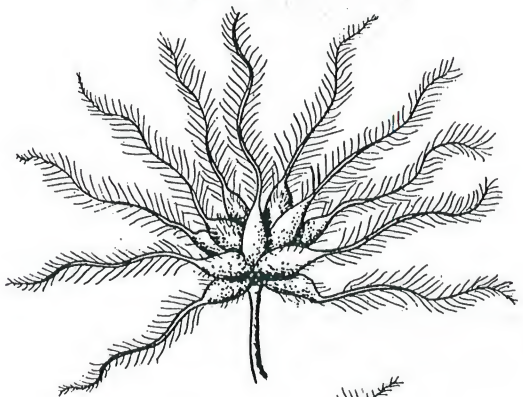
Goat's beard. (Cypsela)



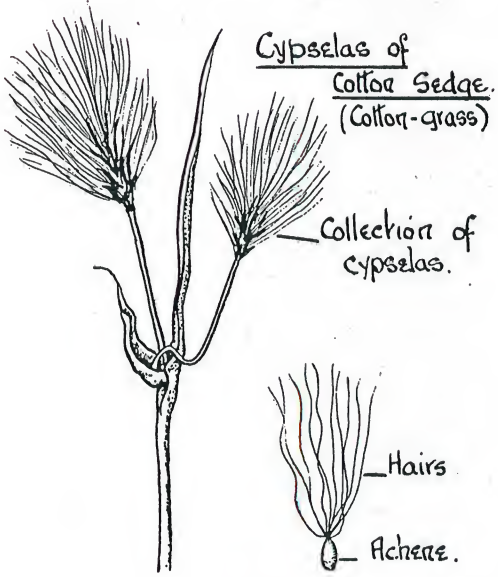
Thistle. Cypsela.



Achenes of Clematis

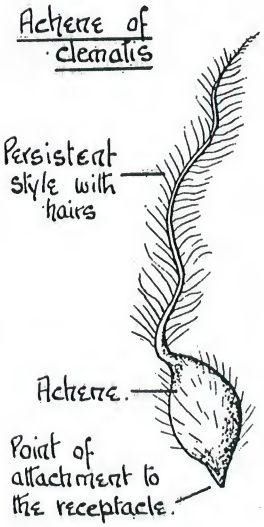


Cypselas of Cotton Sedge. (Cotton-grass)

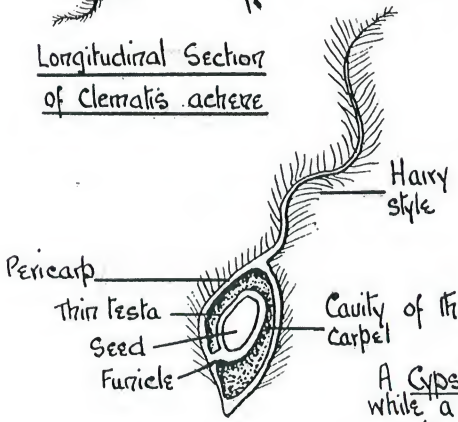


Single fruit.

Achene of clematis



Longitudinal Section of Clematis achene



A Cypsela develops from an inferior ovary of two carpels while a true achene develops from a superior ovary of one carpel.

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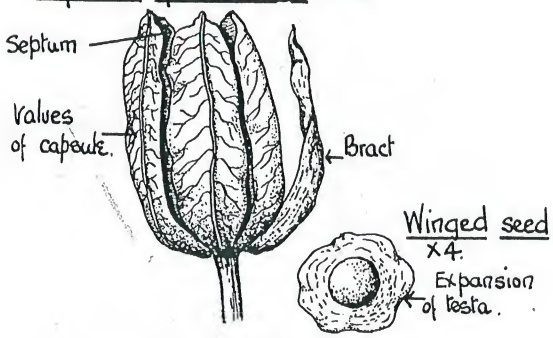
4 c) Increase in surface - Weight much the same (continued).

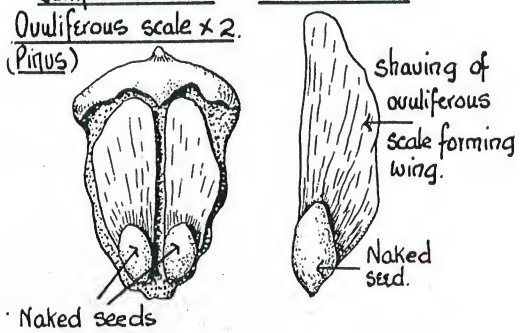
3. Winged seeds.

Capsule of Gladiolus. x 1½.



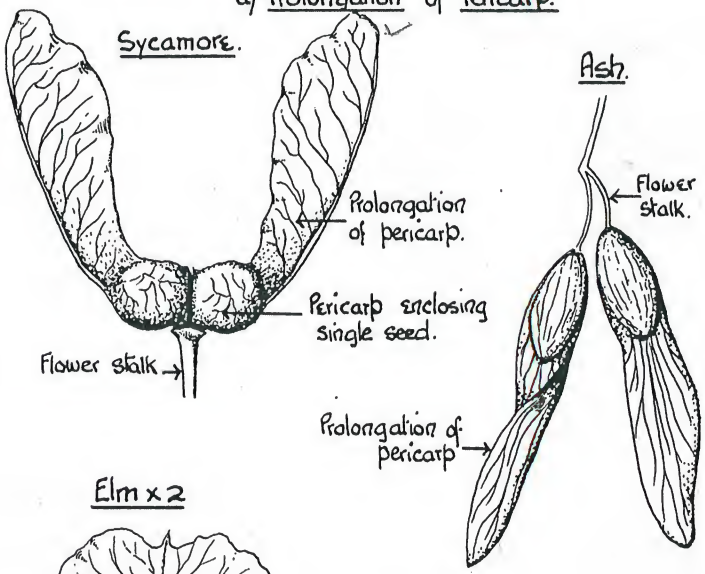
Coniferous Trees - Naked seeds.

Ovuliferous scale x 2. (Pinus)

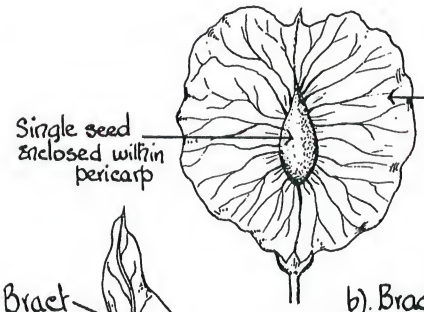


4. Winged fruits

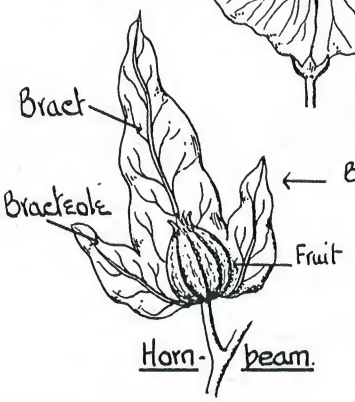
a) Prolongation of Pericarp.

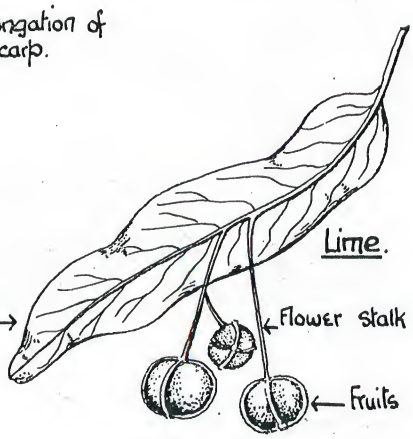


Elm x 2



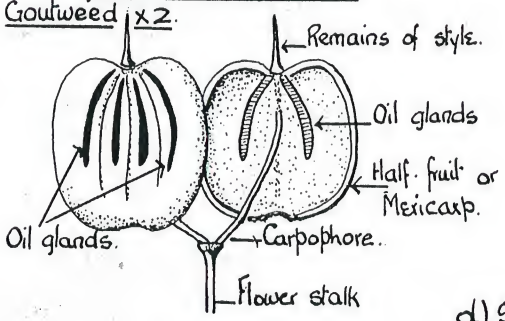
b). Bracts





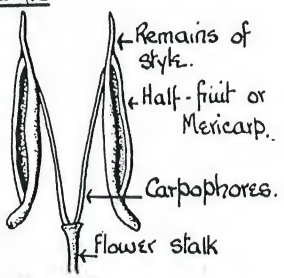
d) Separation of carpels.

Goutweed x 2.

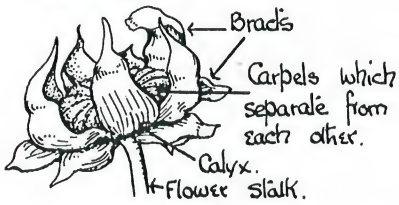


d) Separation of Carpels

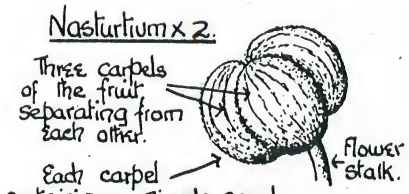
Goutweed x 2



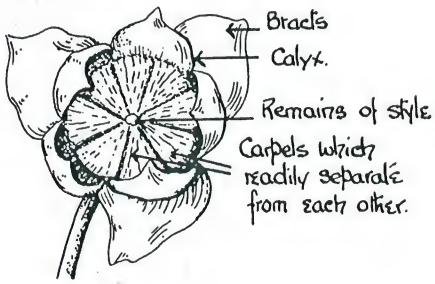
Hollyhock.



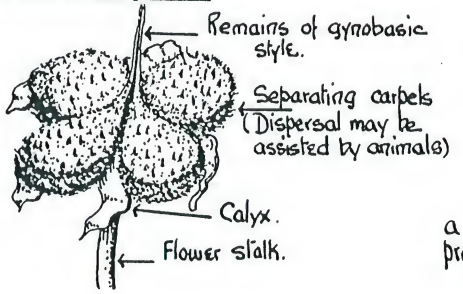
Nasturtium x 2.



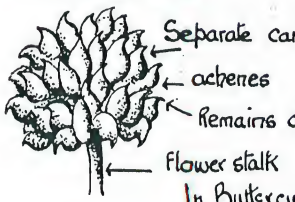
Mallow x 3



Hound's Tongue x 2.



Buttercup x 2.

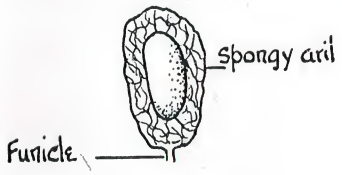


In Buttercup the achenes occur in groups so that a large multiple fruit (Etaerio) is produced by one flower.

M.W.M.J.

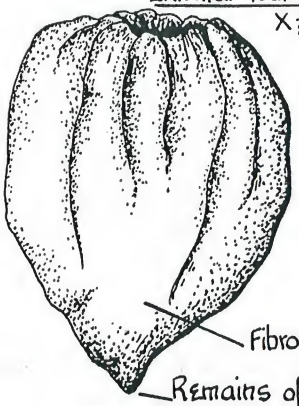
WATER.

a) Spongy aril in Water Lily

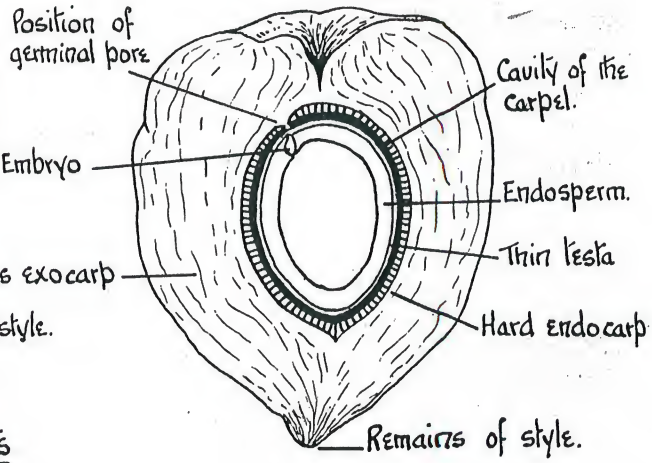


b) Fibrous exocarp in Coconut

External Features $\times \frac{1}{8}$



Longitudinal Section $\times \frac{1}{8}$

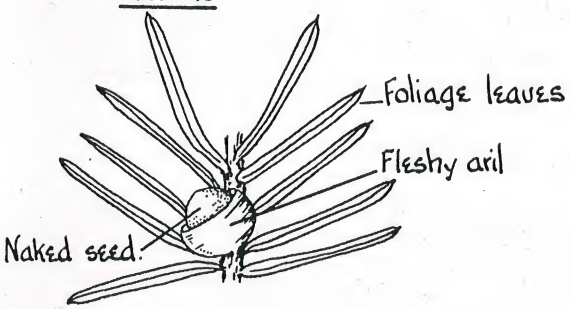


ANIMALS.

a) Birds - Succulent seeds and fruits - False fruits

(1) Succulent seeds

Yew x 2.

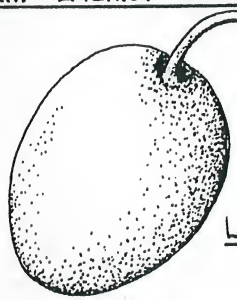


Japanese Spindle Tree x 2

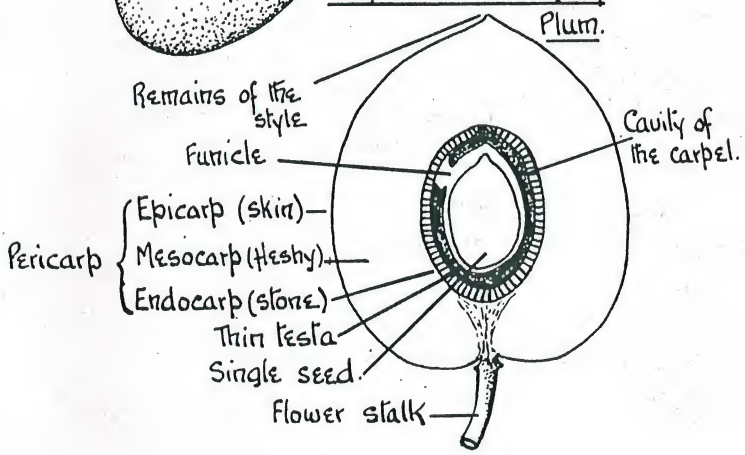
The seeds have bright red arils, and hang by their elastic funicles from the opened capsule.

(2) Succulent fruits (Drupes)

Plum - External Features

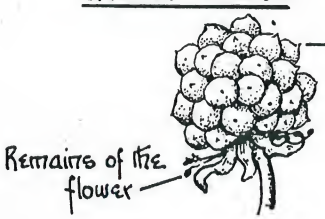


Longitudinal Section of Plum.

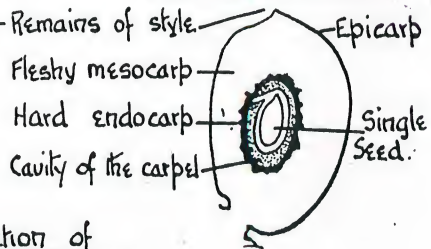


Blackberry - Collection of Drupels.

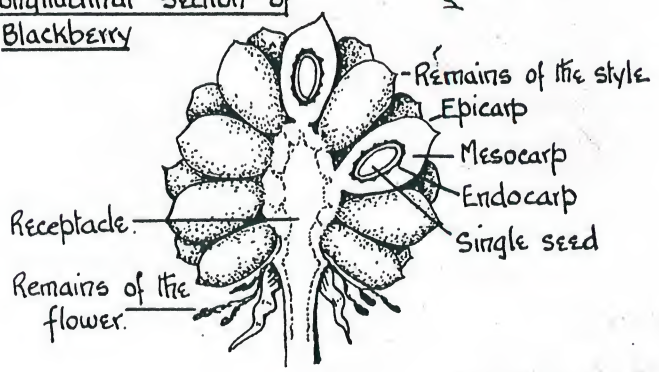
External Features.



L.S. Single drupel



Longitudinal Section of Blackberry



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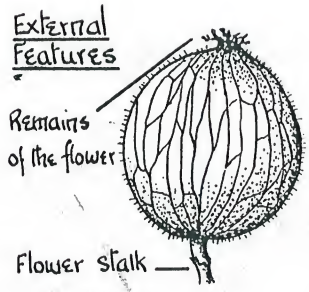
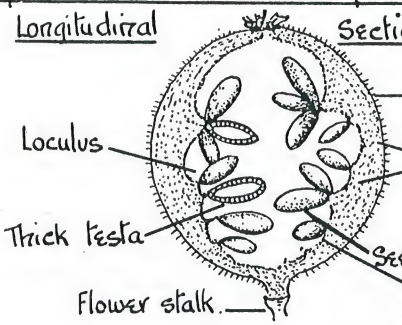
(3) Succulent fruits (Berries)

Gooseberry - Unilocular - Parietal placentation (Inferior ovary)

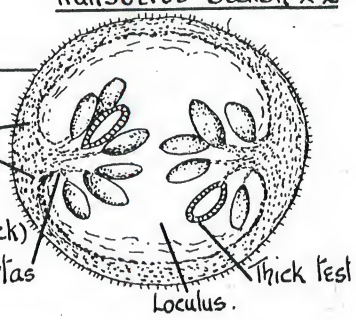
External Features



Longitudinal Section x 2

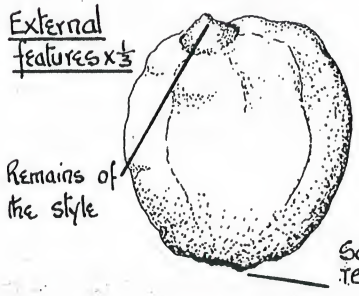


Transverse Section x 2

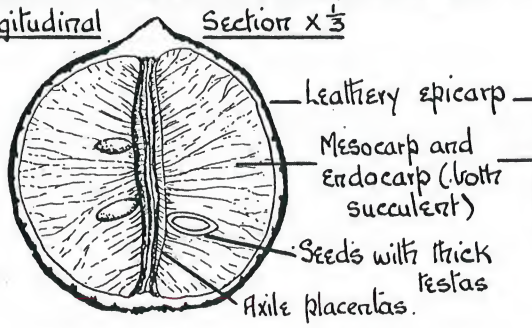


Lemon - Locular - Axile placentation (Superior ovary)

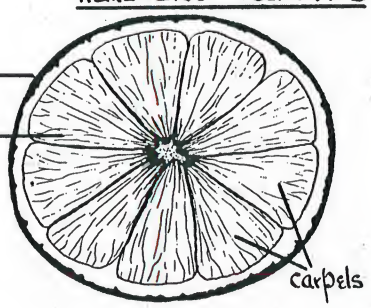
External features x $\frac{1}{3}$



Longitudinal Section x $\frac{1}{3}$



Transverse section x $\frac{1}{3}$

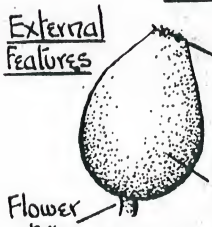


(4) Succulent fruits (False fruits or Pseudocarps)

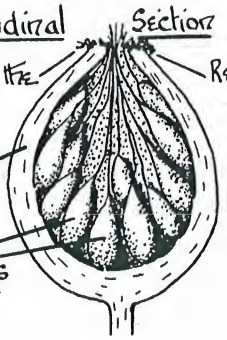
(i) Swollen Receptacle.

Rose Hip

External Features

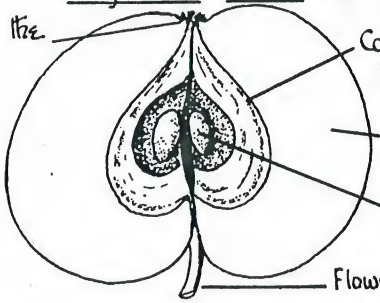


Longitudinal Section

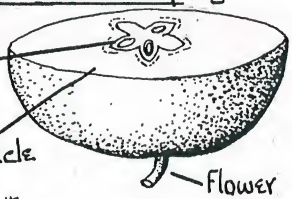


Apple.

Longitudinal Section x $\frac{1}{2}$

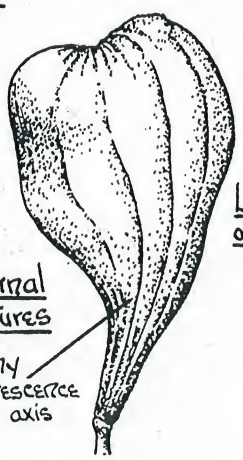


Cut Transversely x $\frac{1}{3}$



Fig

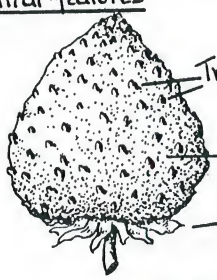
External features



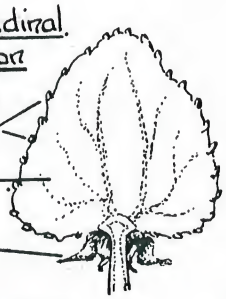
Longitudinal section of Fig.

Strawberry.

External features



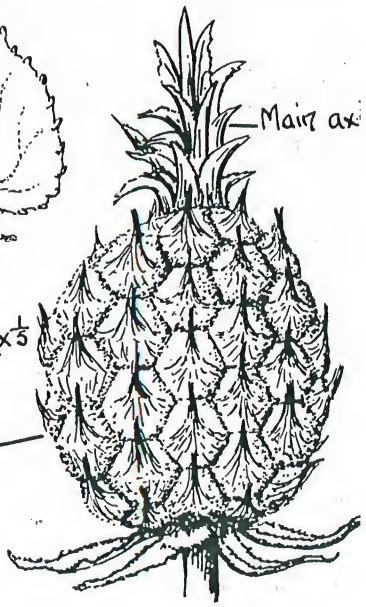
Longitudinal section.



(ii) Fleshy Inflorescence

Mulberry

Pineapple x $\frac{1}{3}$



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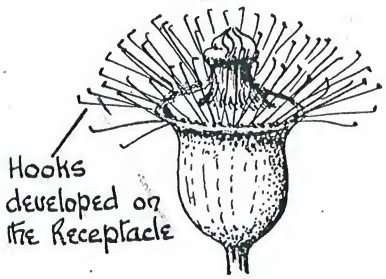
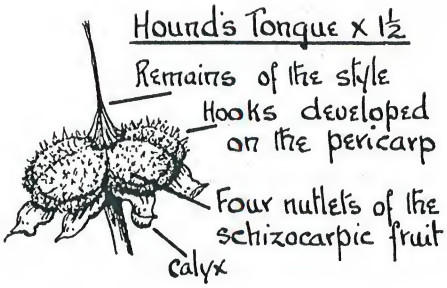
ANIMALS. b) Mammals - Hooked fruits and seeds

Agrimony x 5

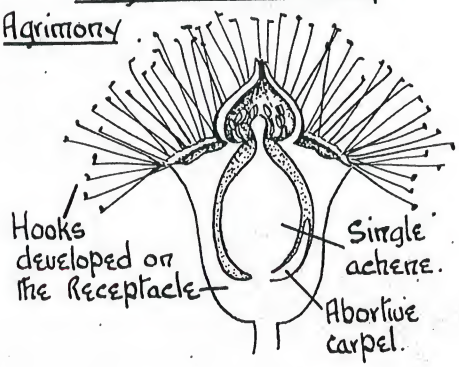


Cleavers x 4

Hound's Tongue x 1½

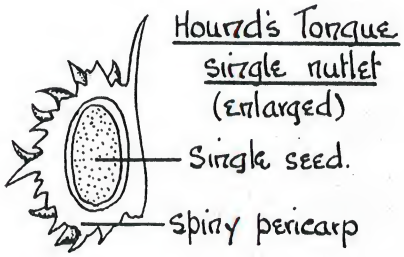


Longitudinal Section of Agrimony



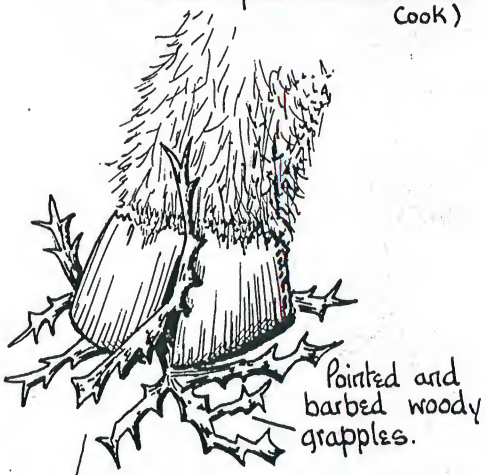
Enchanter's Nightshade x6

Hound's Tongue single nutlet (enlarged)

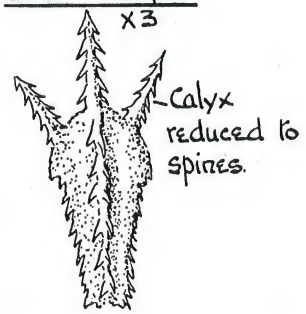


Grapple fruit of South Africa

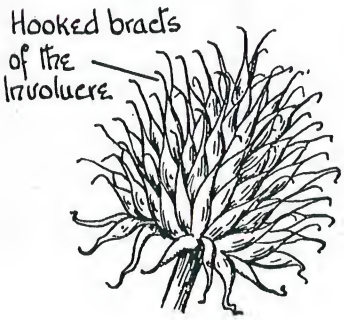
Reduced (from Hentschel and Cook)



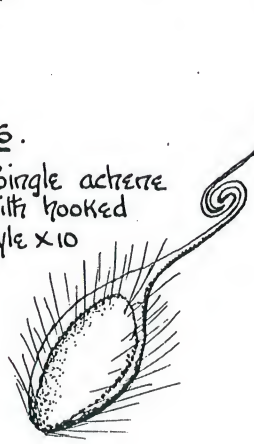
Burr Marigold. x3



Burdock.

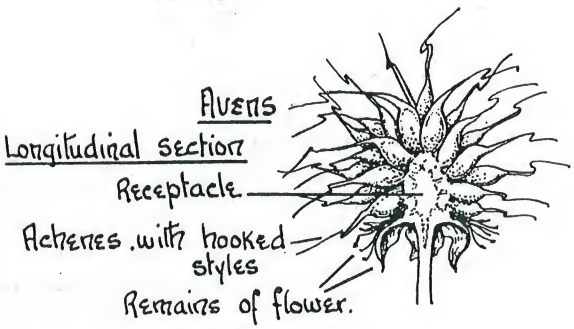


Avens.



Avens. External features

Avens Longitudinal section



ANIMALS. c) Ants - Oily seeds.

Castor Oil seed x1½

Gorse seed x7

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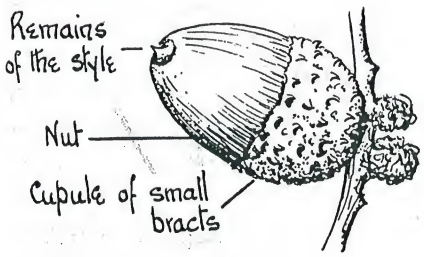
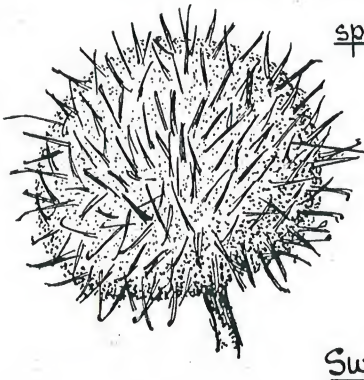
8. ANIMALS - d) Rodents - Nuts and Nutlets (Achenes)

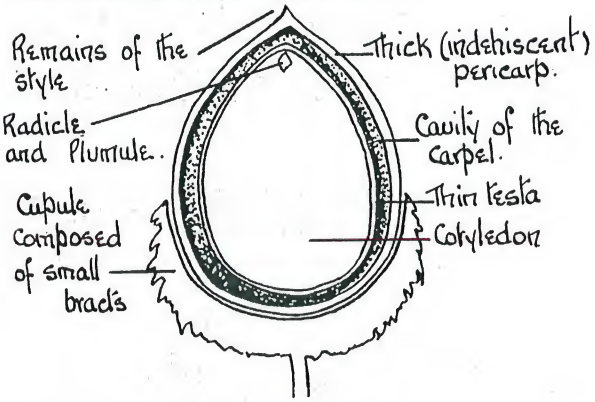
Nut of Oak
Acorn.



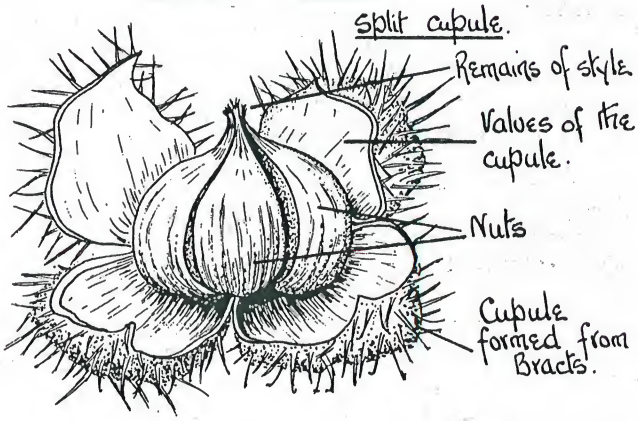
Nuts of Sweet chestnut.



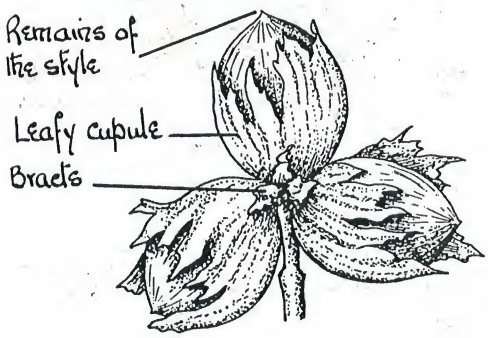
Longitudinal section of Acorn.



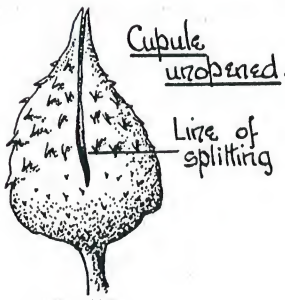
Sweet Chestnut.

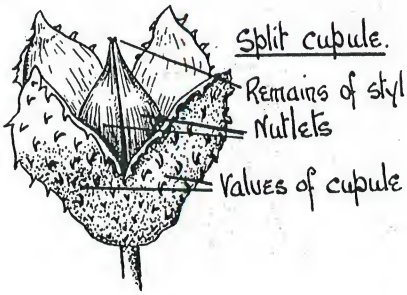


Nuts of Hazel.



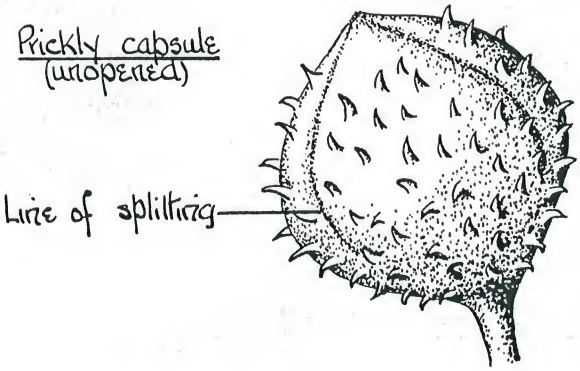
Nutlets of Beech.

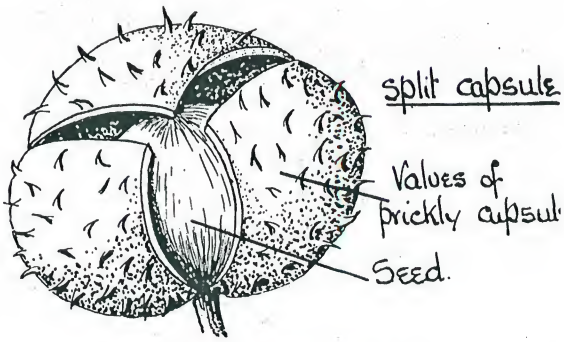




Horsechestnut.

Prickly capsule (unopened)





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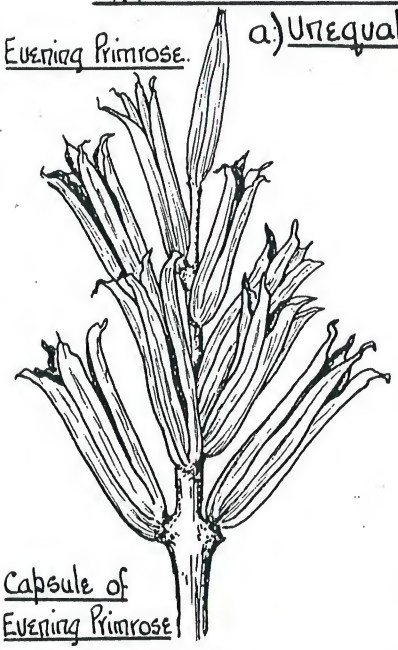
PROPULSIVE or EXPLOSIVE MECHANISM.

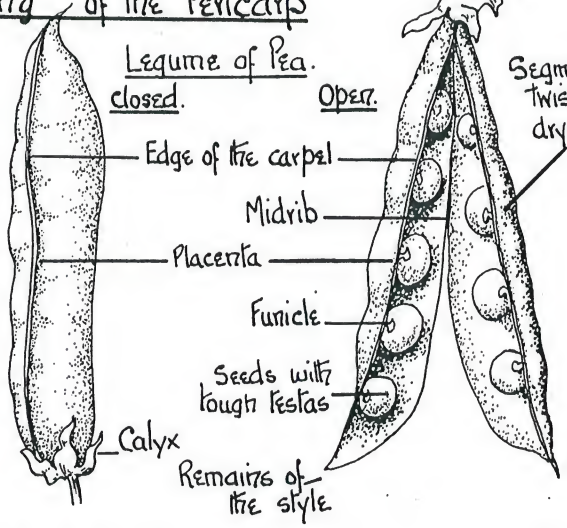
a) Unequal drying of the Pericarp

Evening Primrose.

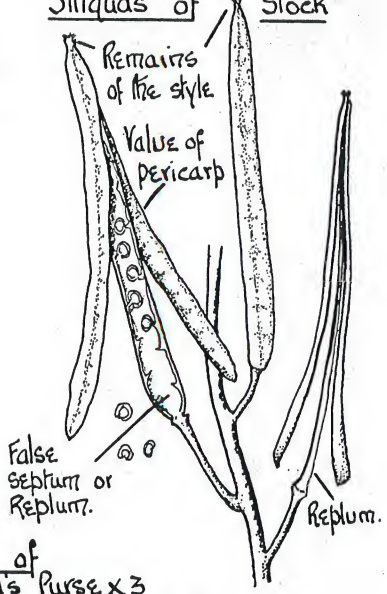


Capsule of Evening Primrose

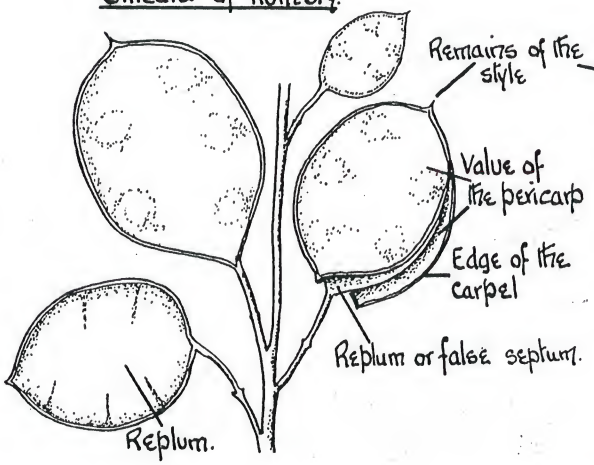
Legume of Pea.



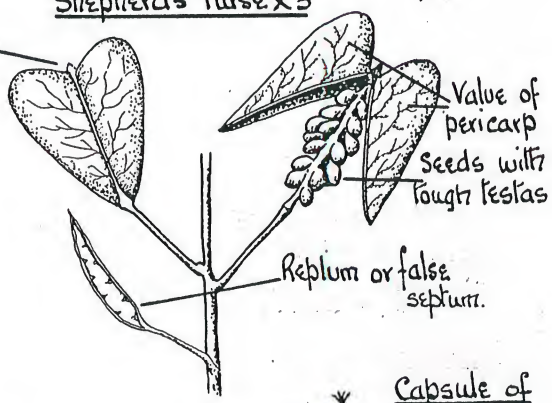
Siliquas of Stock



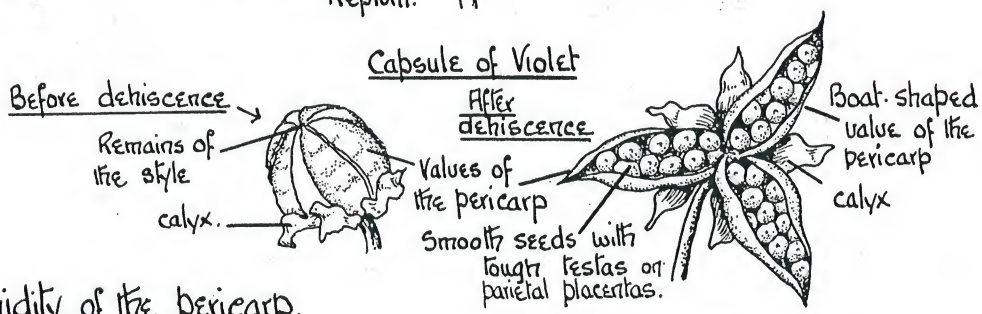
Silicula of Honesty.



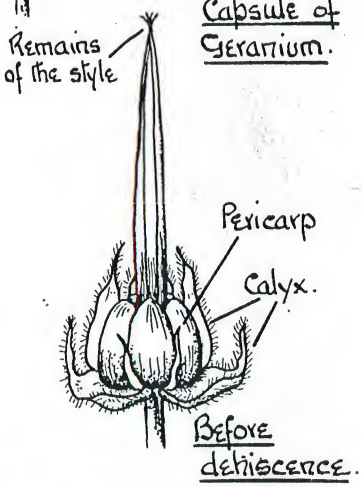
Silicula of Shepherd's Purse x 3



Capsule of Violet

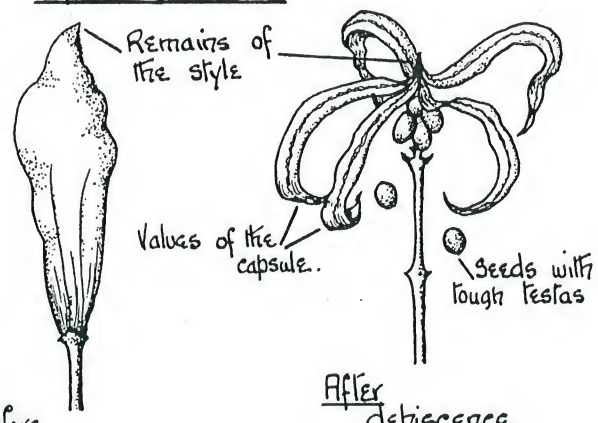


Capsule of Geranium.



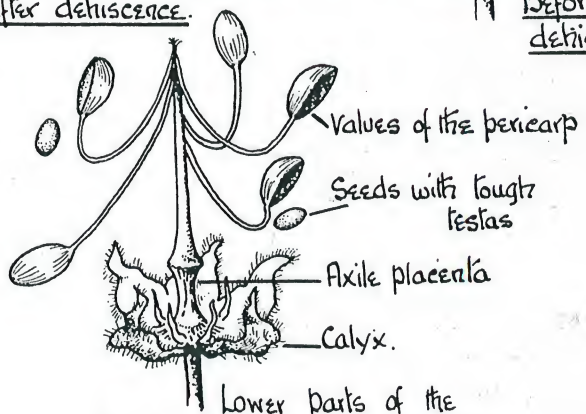
b) Turgidity of the pericarp.

Capsule of Balsam.



Capsule of Geranium.

After dehiscence.



Lower parts of the fused styles suddenly curl up, each carpel dehiscing at the same time

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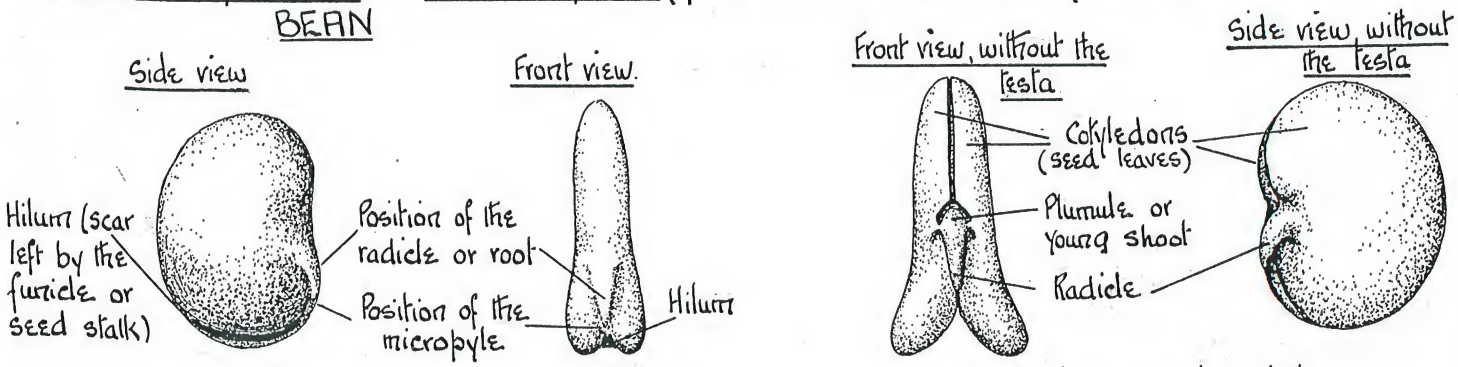
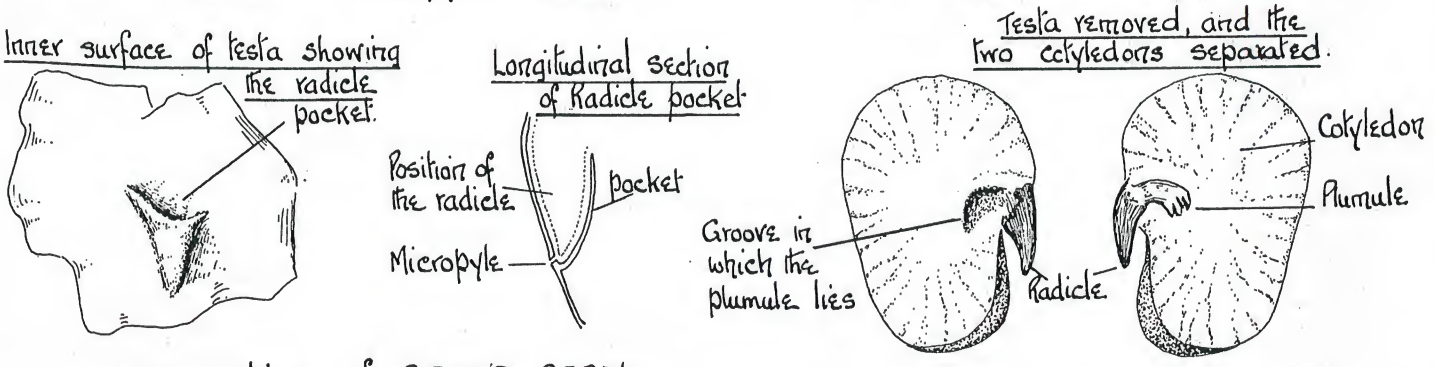
10. # DICOTYLEDONS - SEED STRUCTURE - GERMINATION.

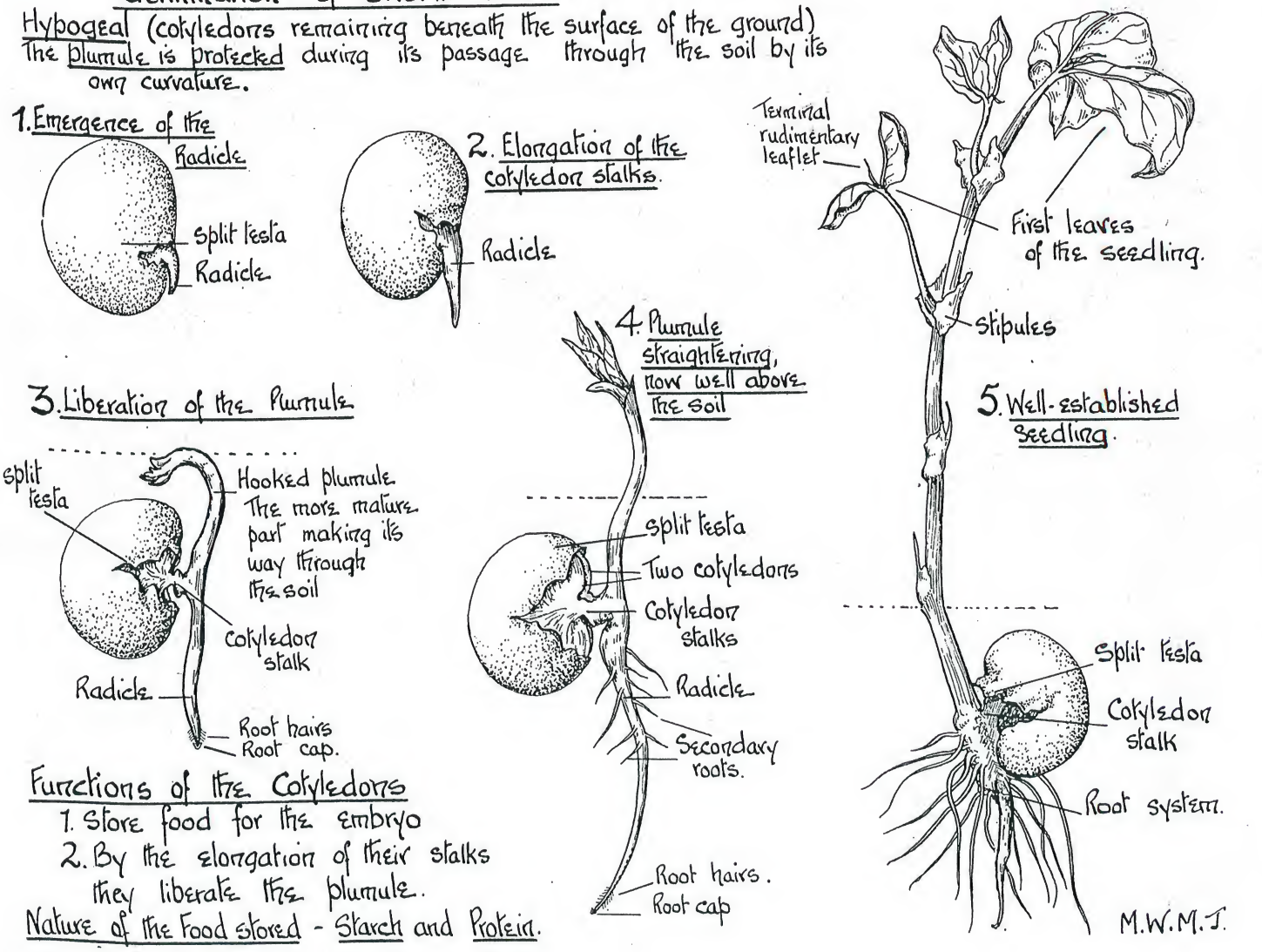
Structure of BROAD BEAN - Non-endospermic (food stored within the cotyledons or seed-leaves)





Germination of BROAD BEAN

Hypogeal (cotyledons remaining beneath the surface of the ground) The plumule is protected during its passage through the soil by its own curvature.



Functions of the Cotyledons

1. Store food for the embryo
2. By the elongation of their stalks they liberate the plumule.

Nature of the Food stored - Starch and Protein.

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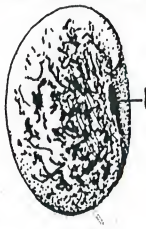
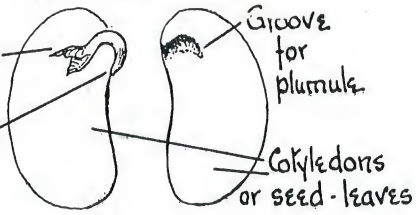
DICOTYLEDONS - SEED STRUCTURE - GERMINATION.

RUNNER BEAN - Non-endospermic

External Features



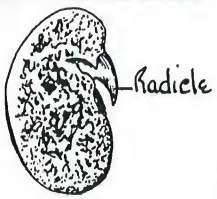
Embryo without testa



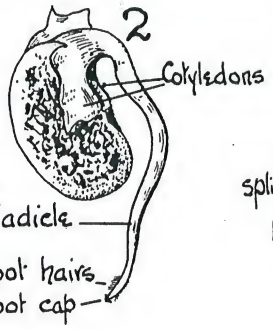
Germination - Hypogeal

Radicle emerging

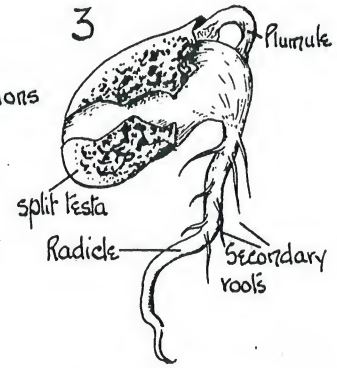
1



2

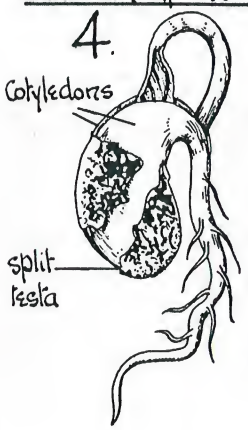


3

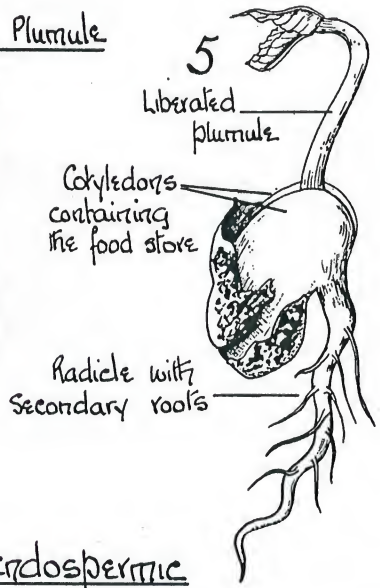


Liberation of the Plumule

4.

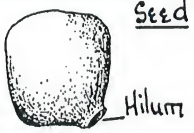


5

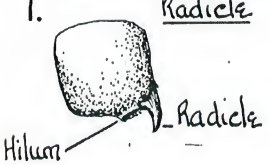


LUPIN - Non-endospermic

External features of the Seed

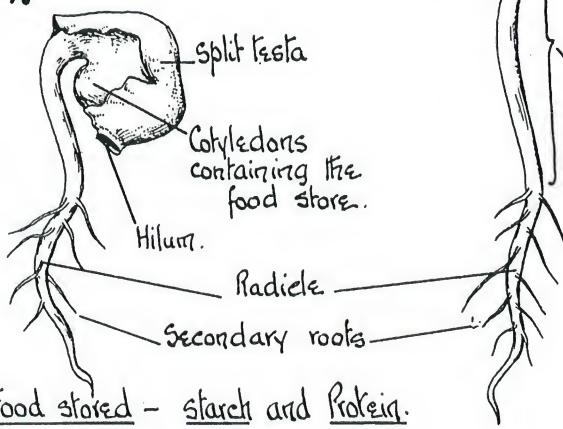


1. Emergence of the Radicle



Germination - Epigeal

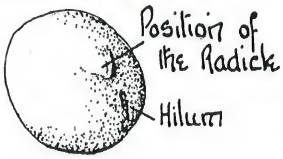
2



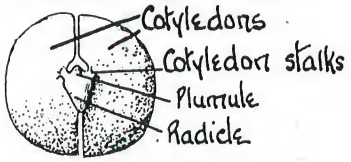
3.

PEA - Non-endospermic

External Features



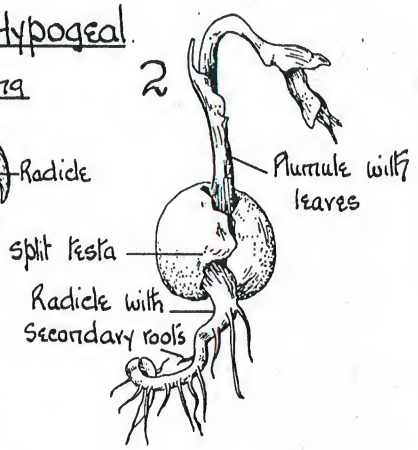
Embryo without testa



Germination - Hypogeal.

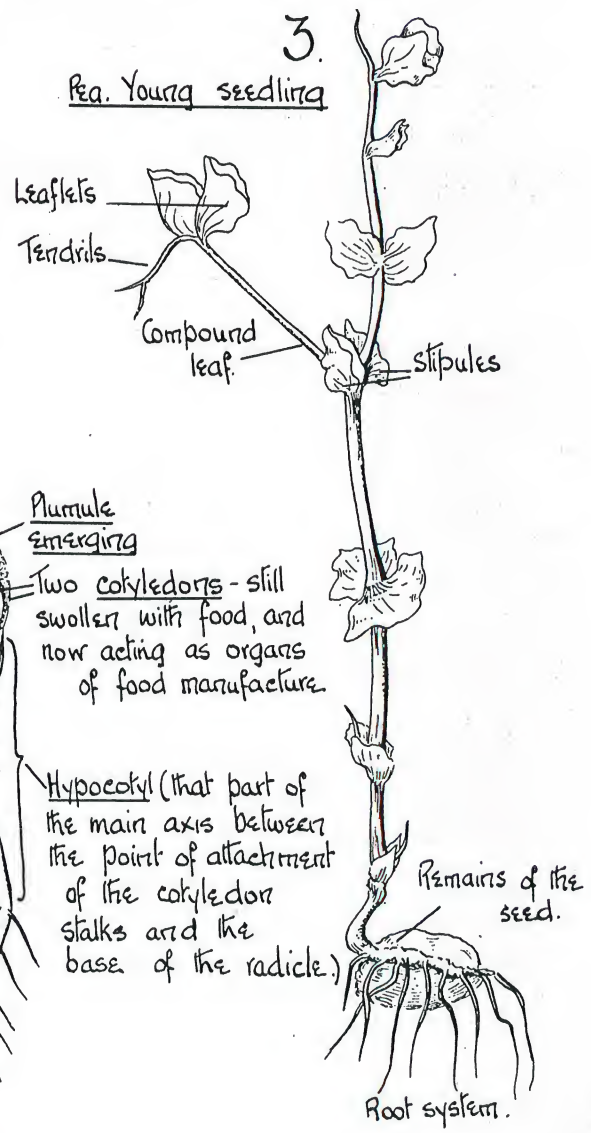
1 Radicle emerging

2



3.

Pea. Young seedling



M.W.M.J.

Nature of the Food stored - starch and Protein.

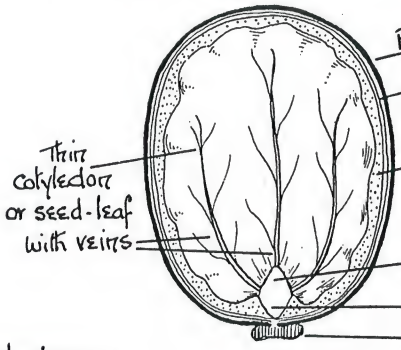
12. DICOTYLEDONS - SEED STRUCTURE - GERMINATION

Structure of CASTOR OIL - Endospermic (food stored outside the embryo)

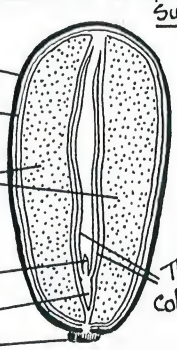
Front View

Side View.

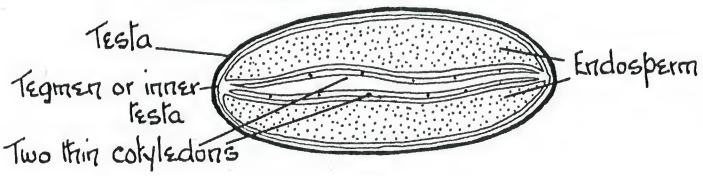
Longitudinal section parallel to the flattened surface.



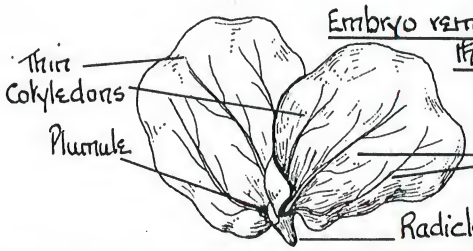
Longitudinal section at rightangles to the flattened surface.



Transverse section



Embryo removed from the seed.



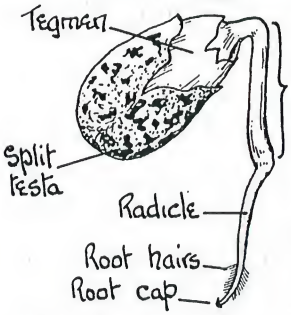
Germination of CASTOR OIL.

Epigeal (cotyledons coming above the surface of the ground)

The plumule is protected during its passage through the soil by the two cotyledons and the curvature of the hypocotyl

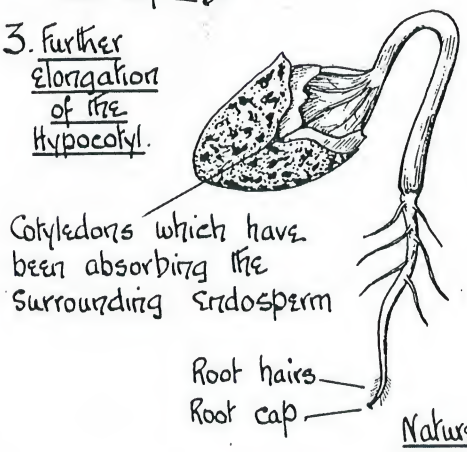
1. Emergence of the Radicle

2. Elongation of the Hypocotyl

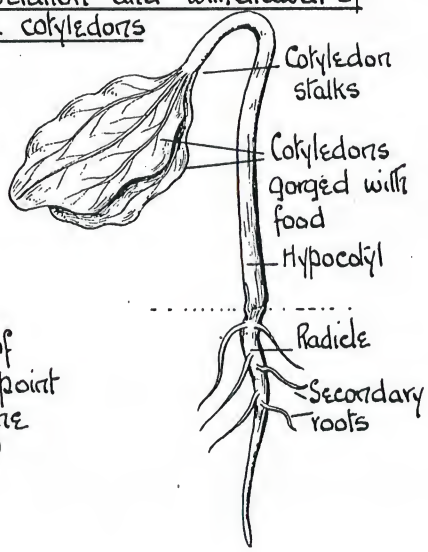


Hypocotyl (Region between the base of the radicle and point of attachment of the cotyledon stalks)

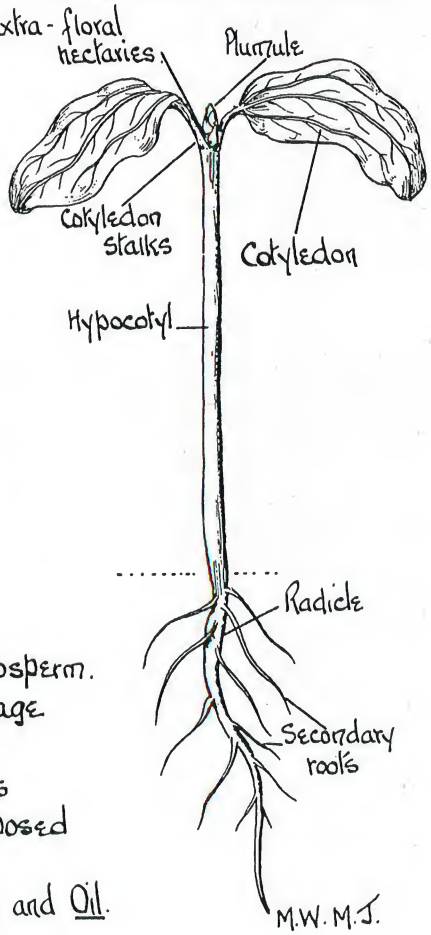
3. Further Elongation of the Hypocotyl.



4 Liberation and withdrawal of the cotyledons



5. Liberation of the Plumule



Functions of the Cotyledons

1. Absorb food from the surrounding endosperm.
2. Protect the plumule during its passage through the soil
3. Develop chlorophyll and so act as photosynthetic organs when exposed to the light.

Nature of the food stored - Protein (aleurone grains) and Oil.

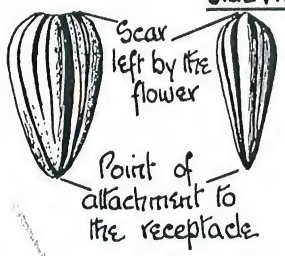
M.W.M.J.

DICOTYLEDONS - SEED STRUCTURE - GERMINATION

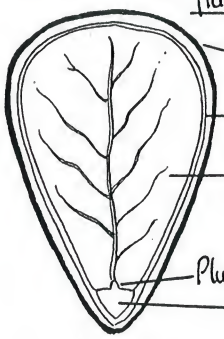
Structure of SUNFLOWER - Non-endospermic (food stored within the cotyledons)

Front View.

Side View

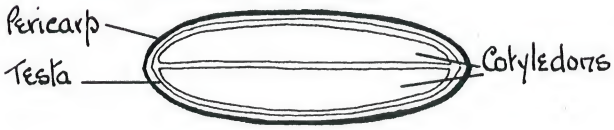


Longitudinal Section parallel to the flattened surface



Longitudinal section at right angles to the flattened surface.

Transverse Section

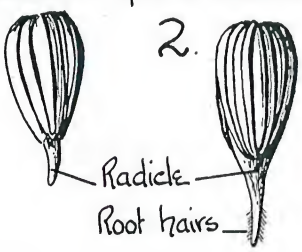


Chemical nature of the food stored - Protein and Oil.

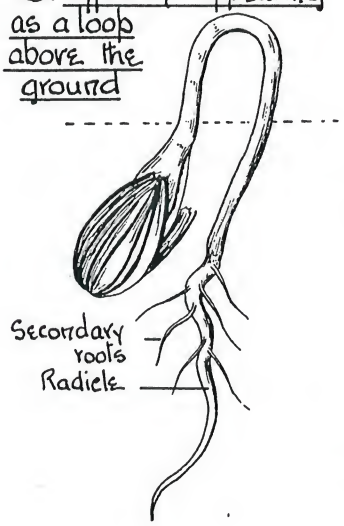
Germination of SUNFLOWER

Epigeal (cotyledons coming above the surface of the ground)
The plumule is protected during its passage through the soil by the two cotyledons and the curvature of the hypocotyl.

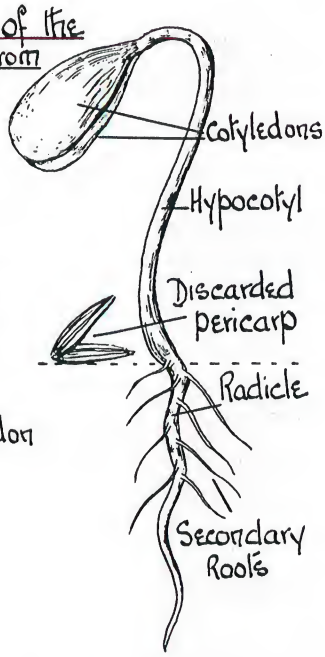
Emergence of the Radicle



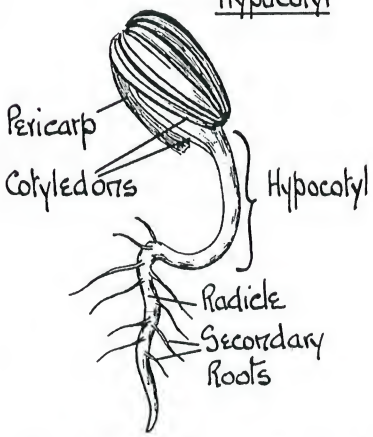
5. Hypocotyl appearing as a loop above the ground



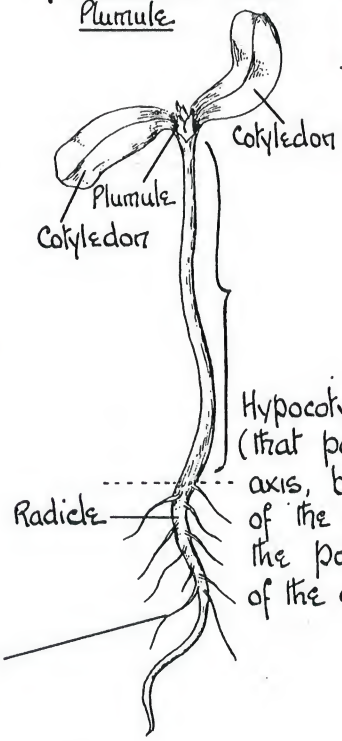
6. Liberation of the cotyledons from the pericarp



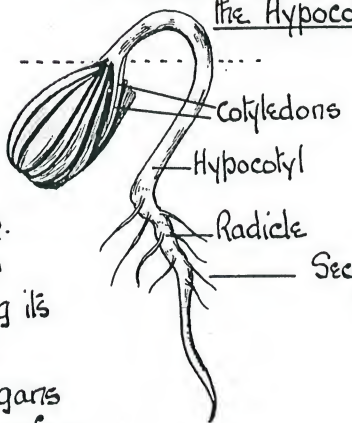
3. Elongation of the Hypocotyl



7. Liberation of the Plumule



4. Further elongation of the Hypocotyl.



Functions of the Cotyledons.

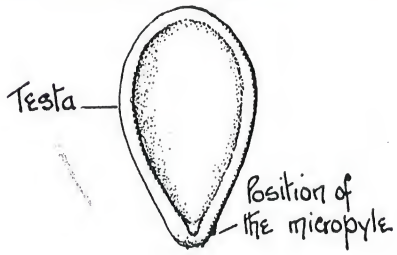
1. Store food for the embryo
2. Protect the plumule during its passage through the soil
3. Act as photosynthetic organs when they reach the surface of the soil.

M.W.M.J.

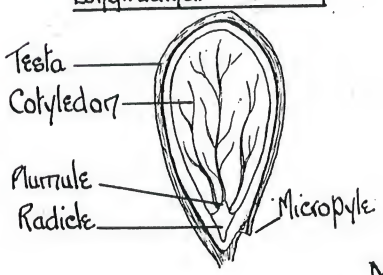
SEED STRUCTURE - GERMINATION

VEGETABLE MARROW - Structure (non-endospermic); Germination (epigeal)

Seed - External Features.



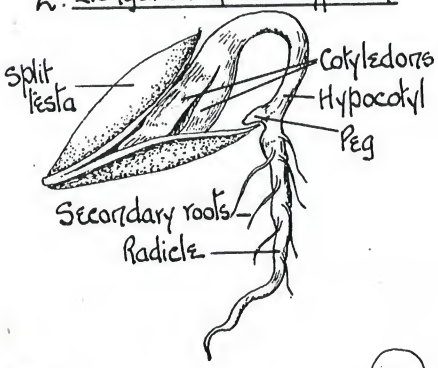
Longitudinal Section



Germination

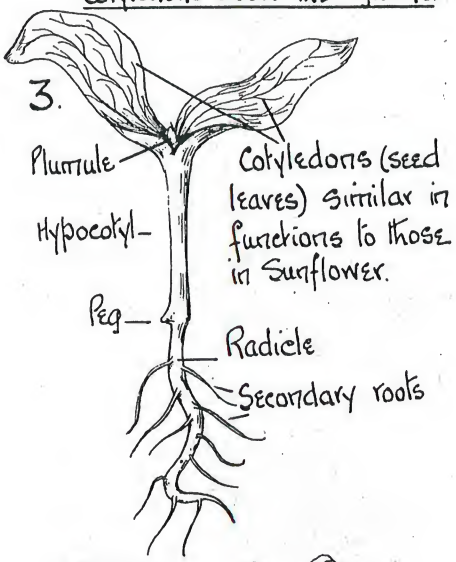
1. Radicle emerging

2. Elongation of the Hypocotyl



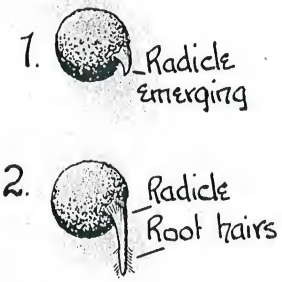
Cotyledons above the ground

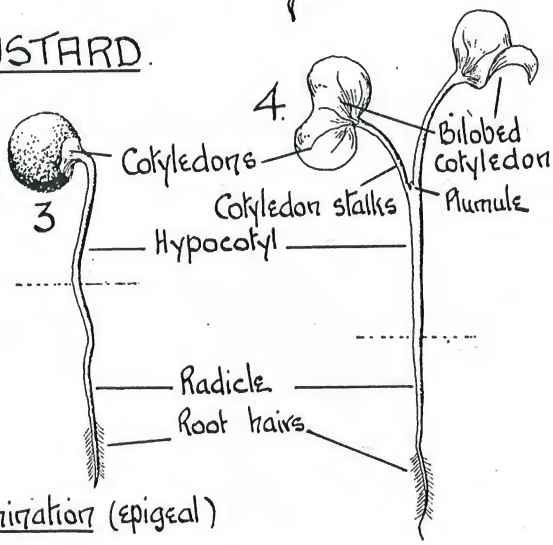
3.



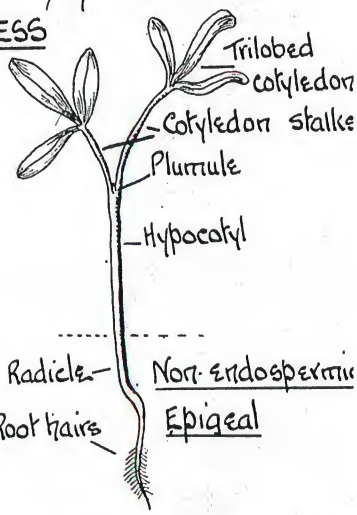
MUSTARD.

Structure (non-endospermic)
Germination (epigeal)





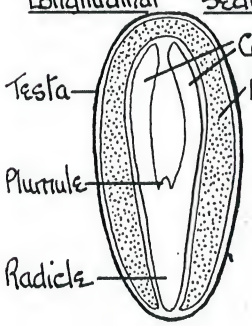
CRESS



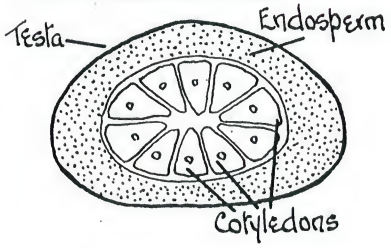
PINE (Polycotyledon)

Structure (endospermic); Germination (epigeal)

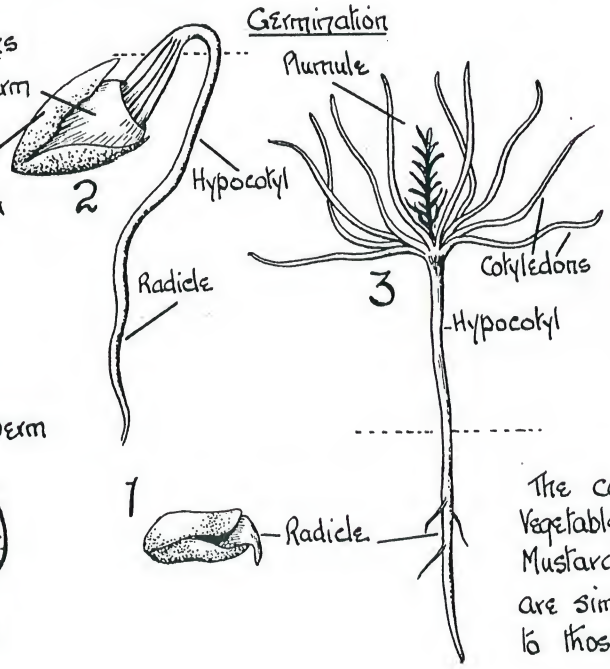
Longitudinal Section



Transverse section



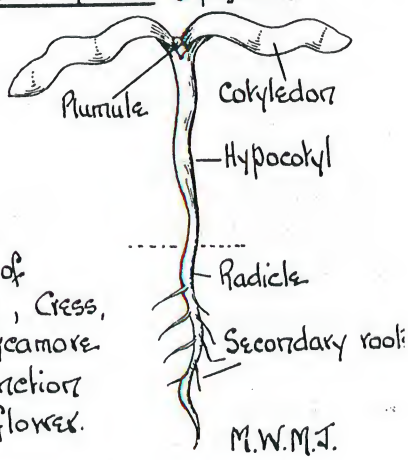
Germination



SYCAMORE FRUIT

Seed - (non-endospermic)

Germination (epigeal)



The cotyledons of Vegetable Marrow, Cress, Mustard and Sycamore are similar in function to those of Sunflower.

M.W.M.J.

Structure of ONION - Endospermic (food stored outside the embryo)

External features

Longitudinal section of the seed from the edge to the opposite face.

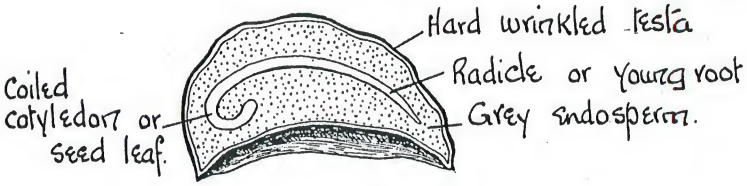


Diagram of the Embryo

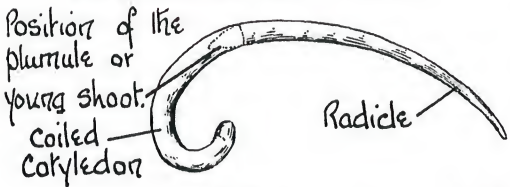
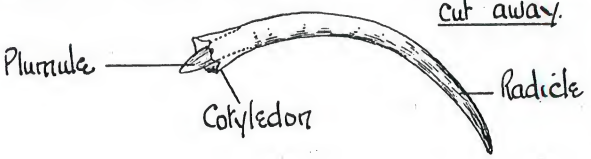


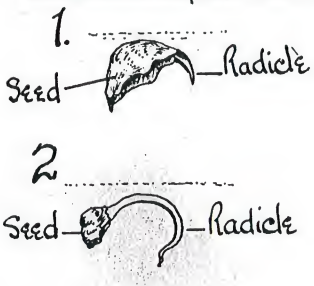
Diagram of the embryo. Tube-like cotyledon cut away.



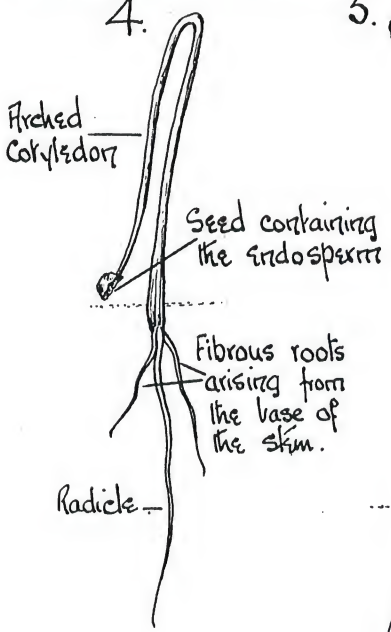
Germination of ONION

Epigeal (the cotyledon coming above the ground)
The plumule is protected during its passage through the soil by the tube-like cotyledon.

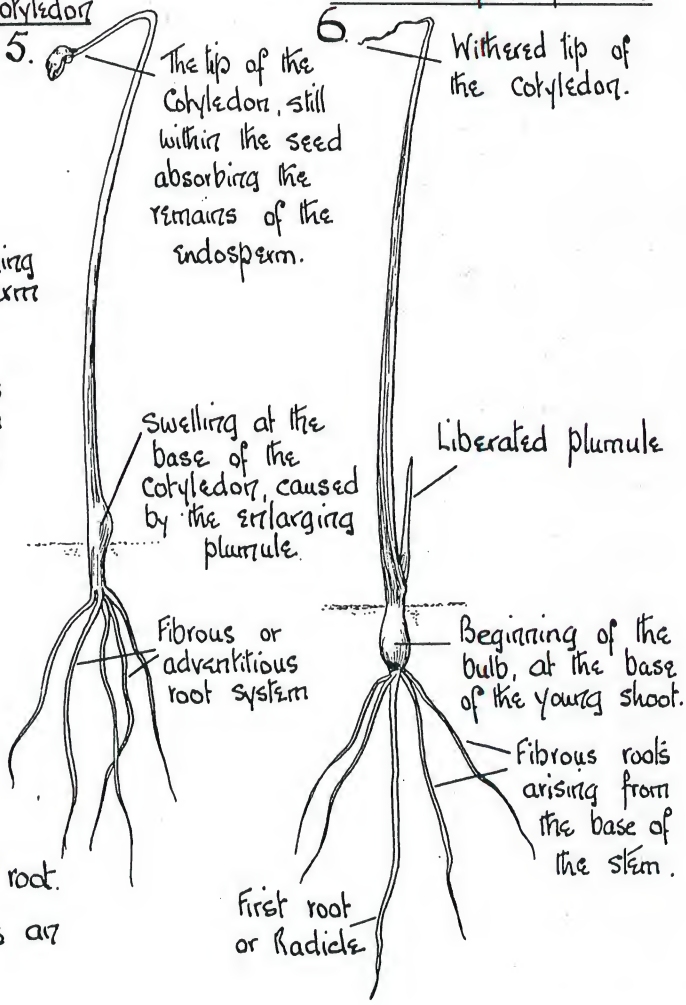
Emergence of the Radicle.



Further elongation of the Cotyledon



Liberation of the plumule



Functions of the Cotyledon:

1. The tip absorbs the food from the endosperm and passes it on to the developing shoot and root.
2. Being green (presence of chlorophyll), it acts as an organ of food manufacture.
3. It protects and liberates the plumule.

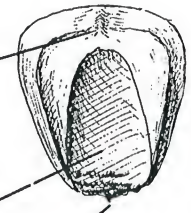
M.W.M.J.

16 MONOCOTYLEDONS - SEED STRUCTURE - GERMINATION

Structure of MAIZE Endospermic (food stored outside the embryo)

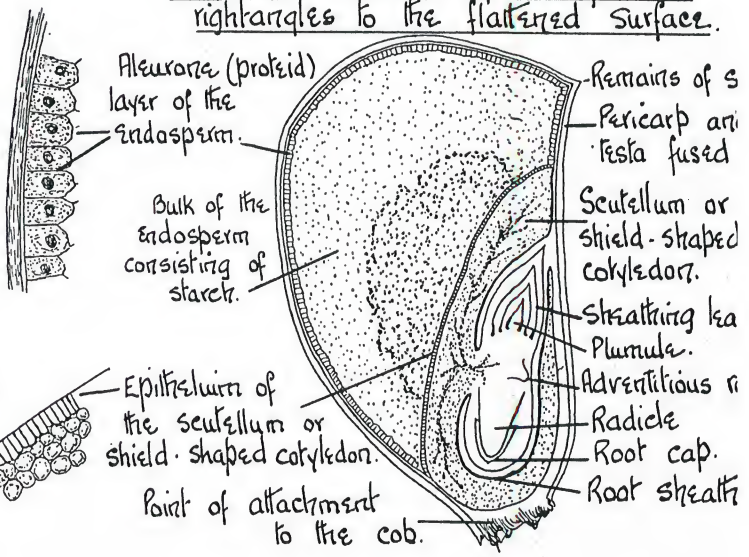
External features.

Front view.



Side view.

Longitudinal section of the fruit at rightangles to the flattened surface.



Point of attachment to the cob.

Chemical nature of the food stored - starch and Protein

Germination of MAIZE.

Hypogeal (the cotyledon remaining beneath the surface of the ground)

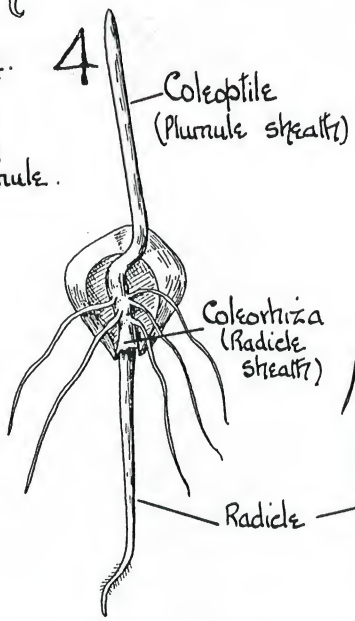
Emergence of the Radicle

1.

2. Liberation of the plumule

2. Liberation of the plumule.

4



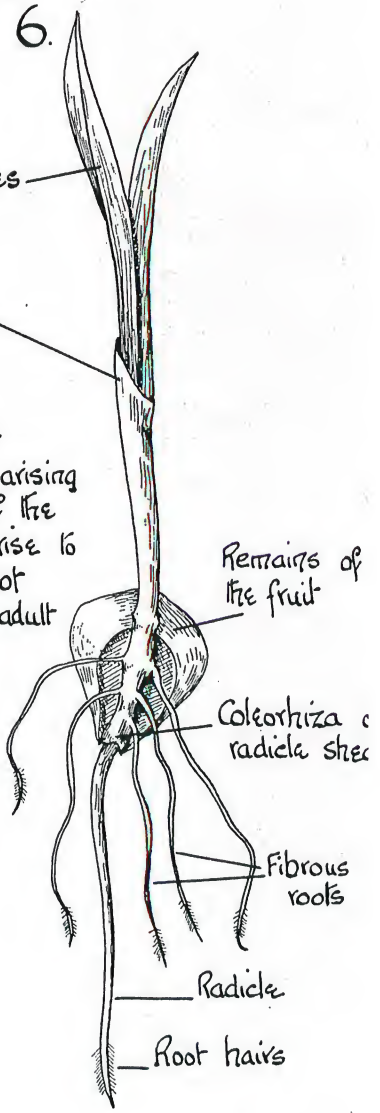
Further elongation of the embryo

3

The appearance of the first foliage leaves of the plumule.

5.

6.



The plumule is protected during its passage through the soil by its own sheathing leaf or coleoptile, while it is liberated by its own growth.

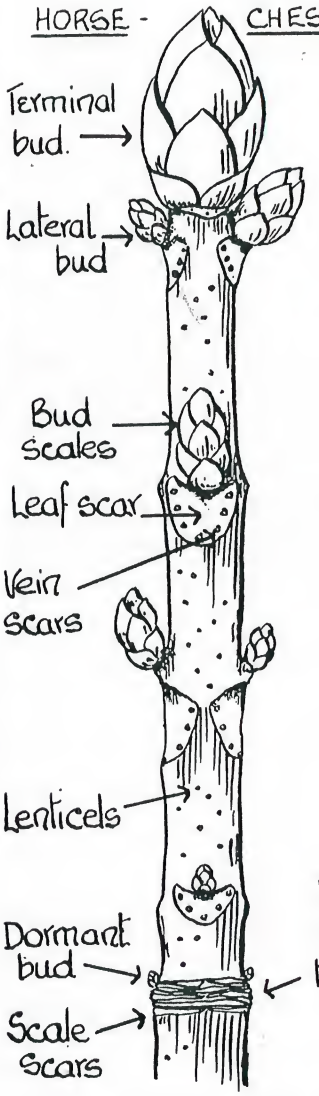
Functions of the Cotyledon.

1. Secretes the enzymes (ferments) which bring about the necessary change of the food of the endosperm.
2. Absorbs the changed food of the endosperm and passes it to the growing root and shoot system.

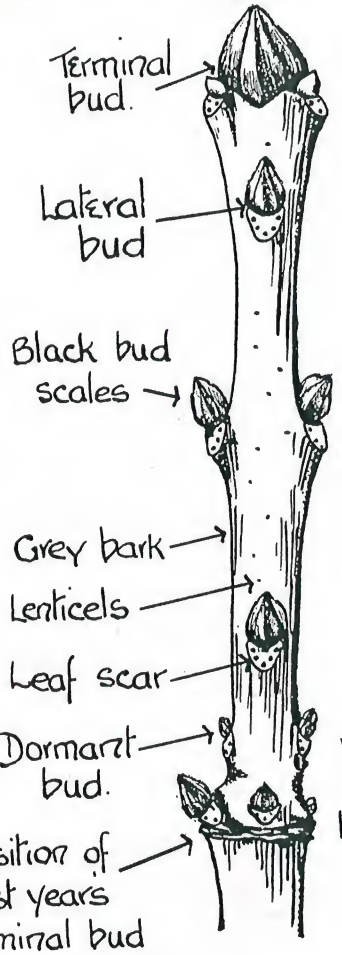
M.W.M.J.

BUDS AND BRANCHES - MONOPODIA.

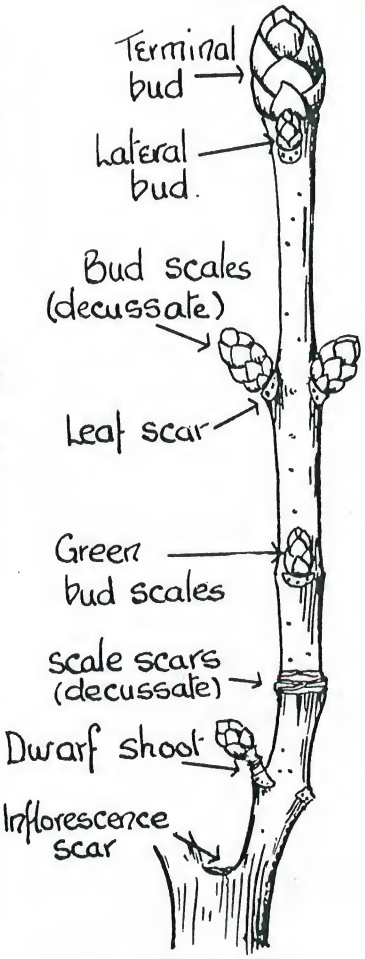
HORSE - CHESTNUT.



ASH

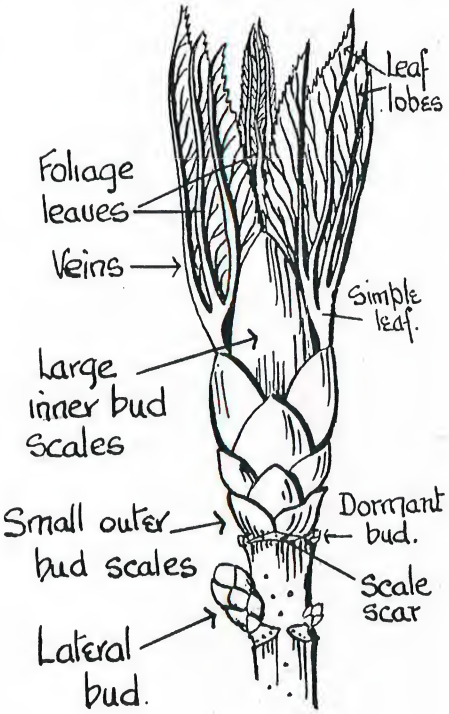


SYCAMORE

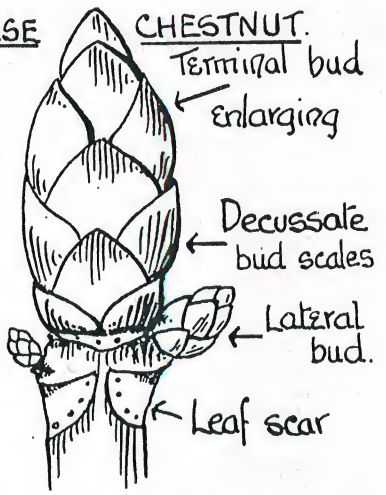


SYCAMORE

Terminal bud opening.

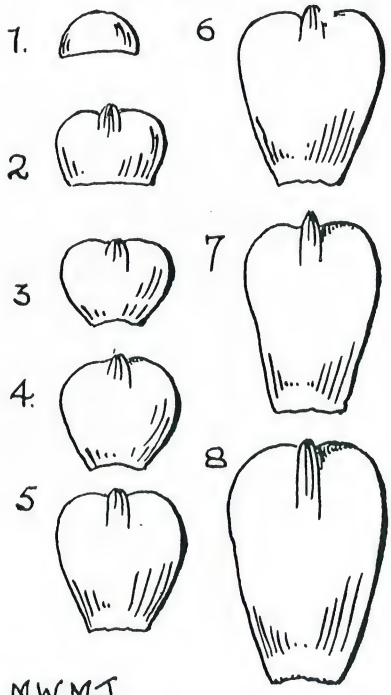


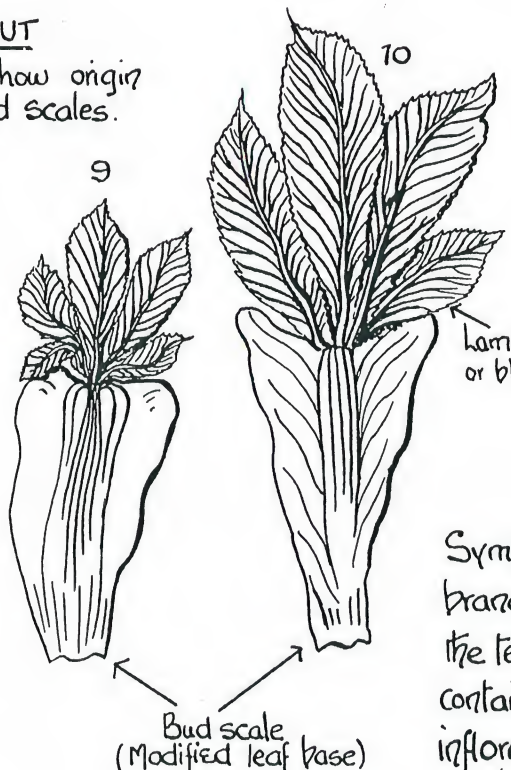
HORSE CHESTNUT.



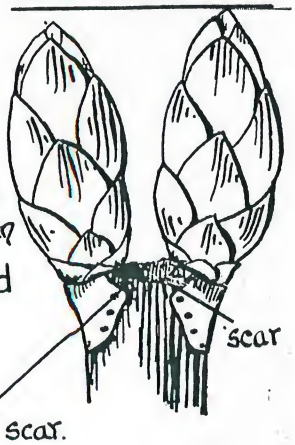
HORSECHESTNUT

Terminal bud dissected to show origin of bud scales.





HORSECHESTNUT.



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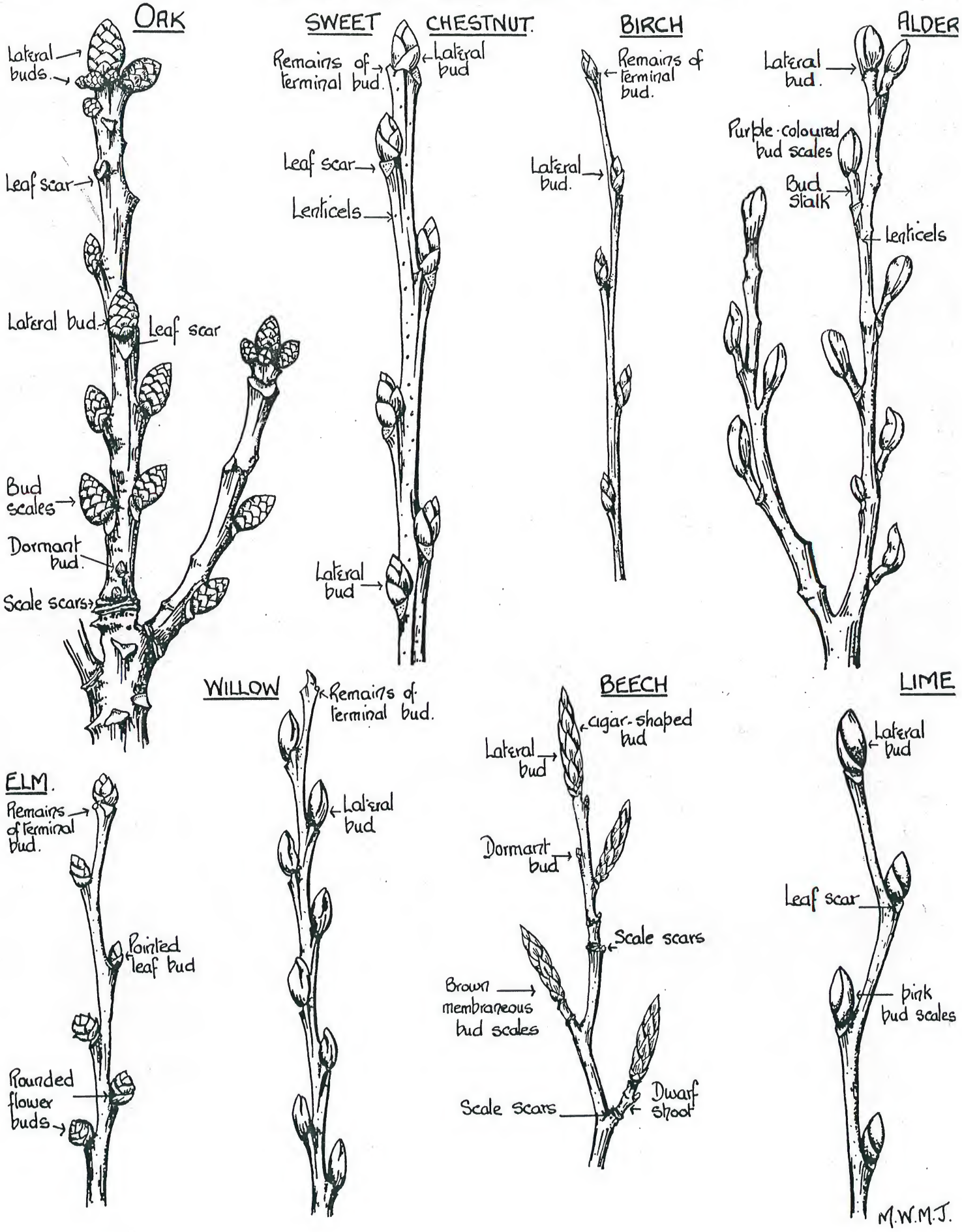
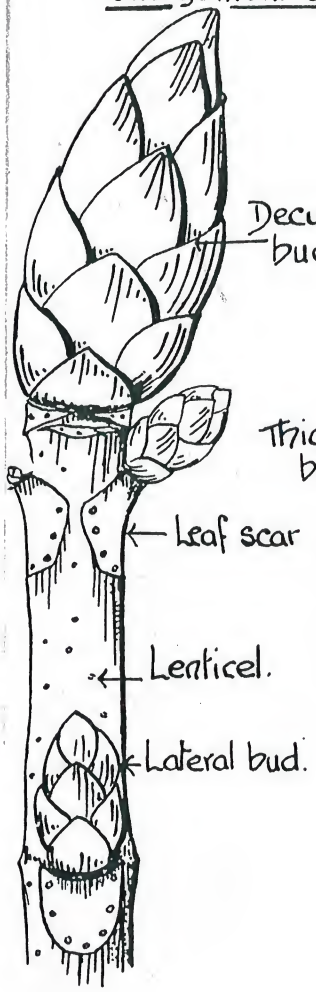
BUDS AND BRANCHES - SYMPODIA



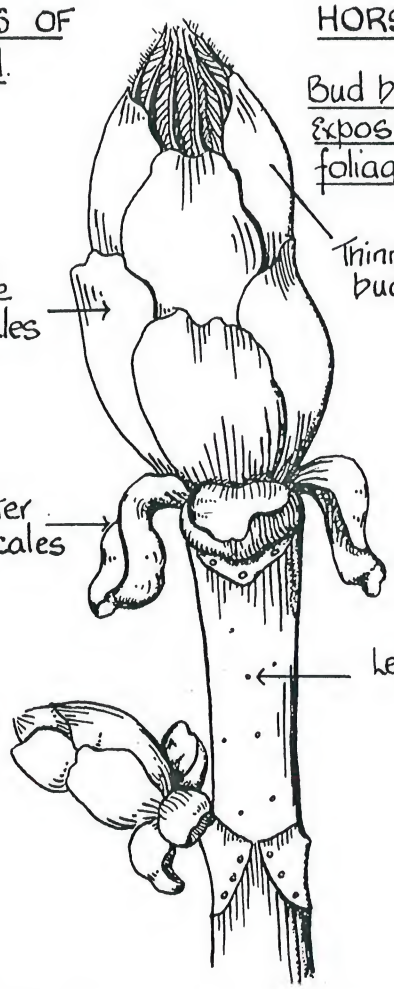
HORSECHESTNUT.

OPENING BUDS OF

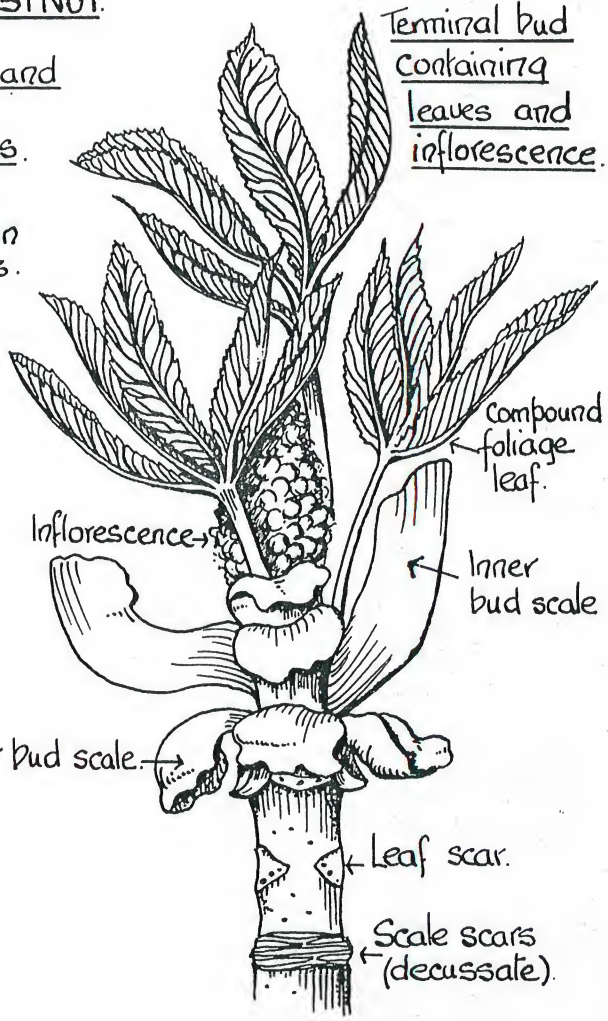
Enlargement of Bud.



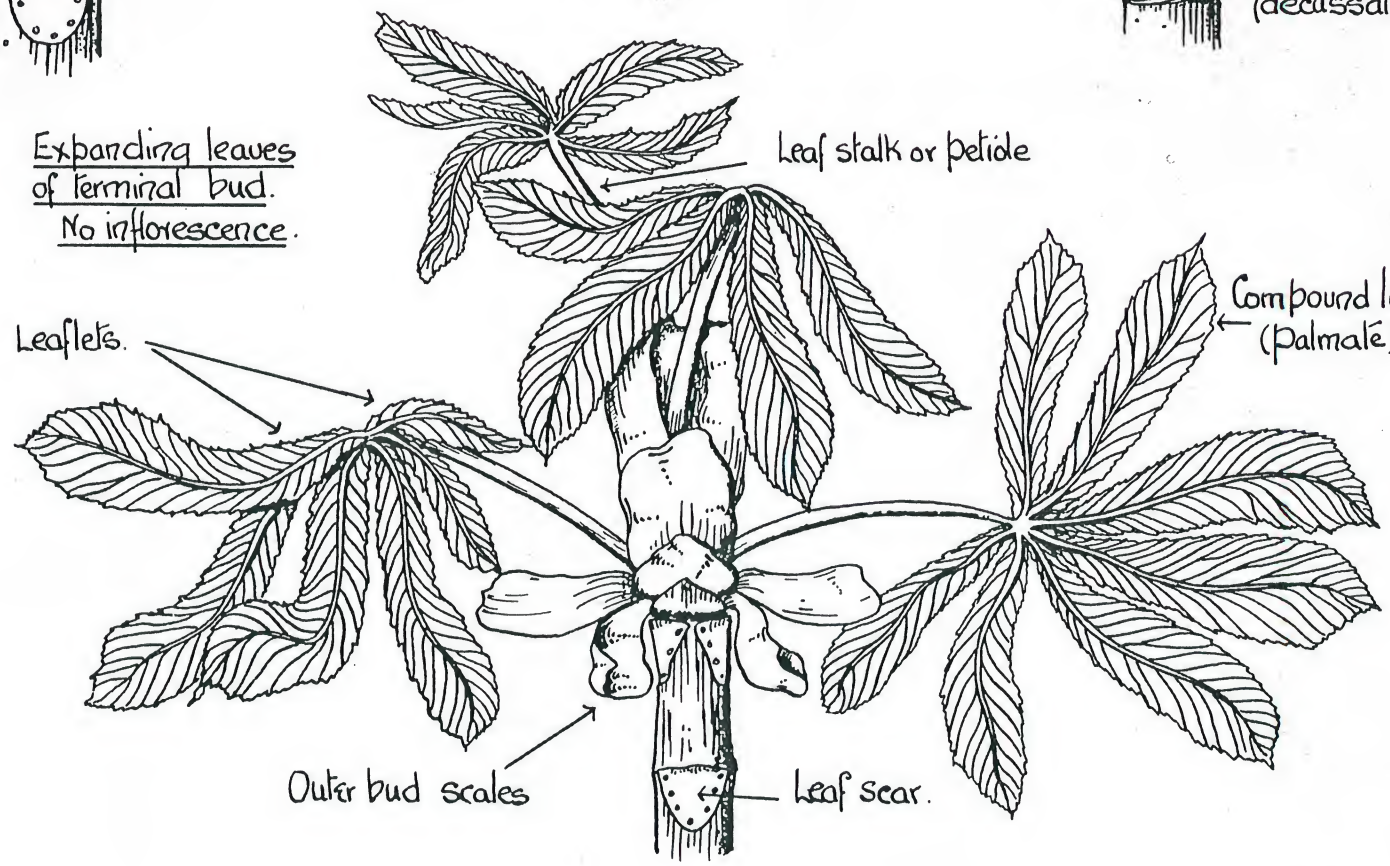
Bud bursting and exposing foliage leaves.



Terminal bud containing leaves and inflorescence.



Expanding leaves of terminal bud. No inflorescence.



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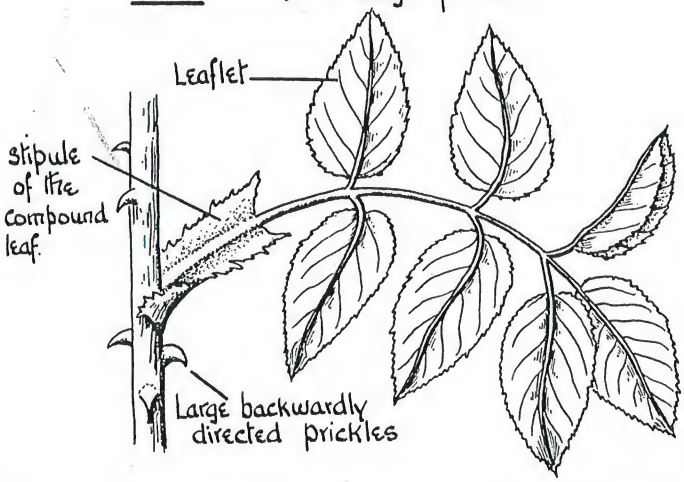
CLIMBING PLANTS

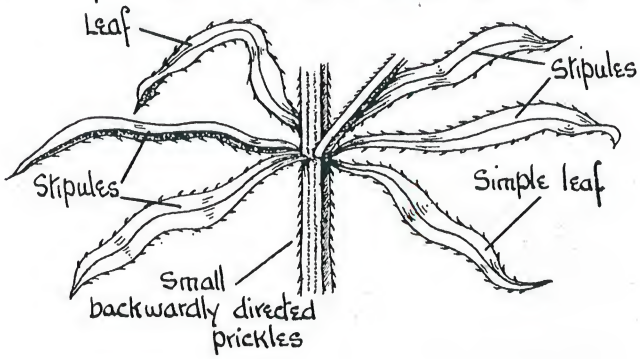
1. Scramblers or Sprawlers - e.g. Stitchwort etc - No definite climbing organs.

2. Prickles - backwardly directed prickles - e.g. Rose, Bramble, Goosegrass etc.

Rose - Few, but large prickles.



Goosegrass (Cleavers) – Many, but small prickles, making the surface adhesive.



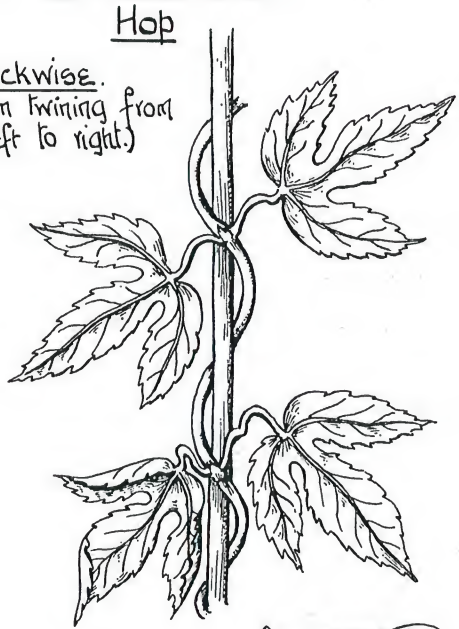
3. Stem Twiners

Convolvulus

Anti-clockwise. (Stem twining from right to left.)

Hop

Clockwise. (Stem twining from left to right.)



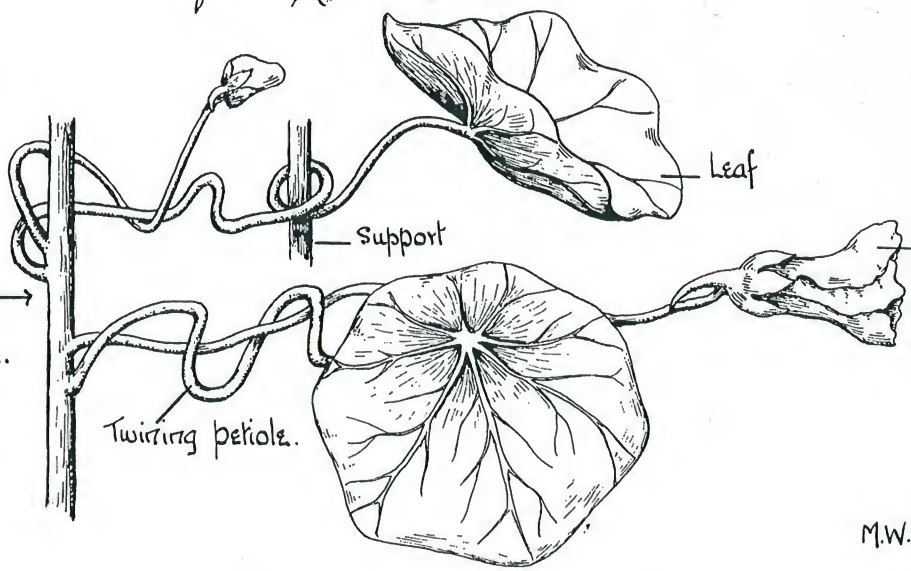
Honeysuckle (clockwis

Stems twine around each other, to form a thick rope.

4. Petiolate tendrils

Nasturtium. →

Petioles - long and sensitive. In Clematis the twining petioles are persistent.



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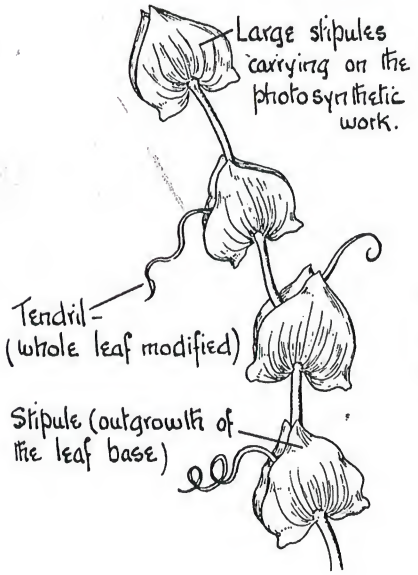
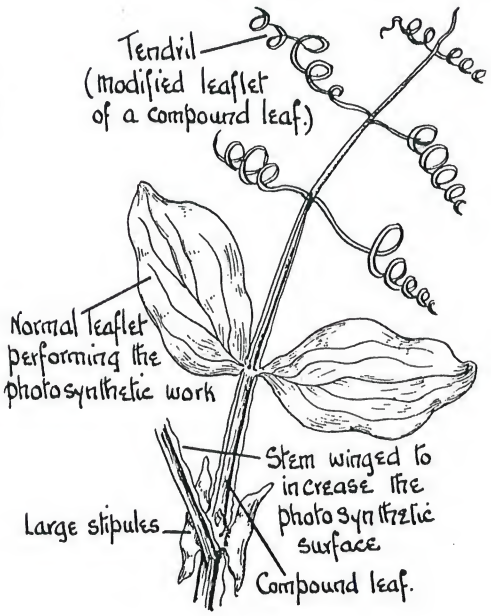
CLIMBING PLANTS (continued)

5. Tendrils

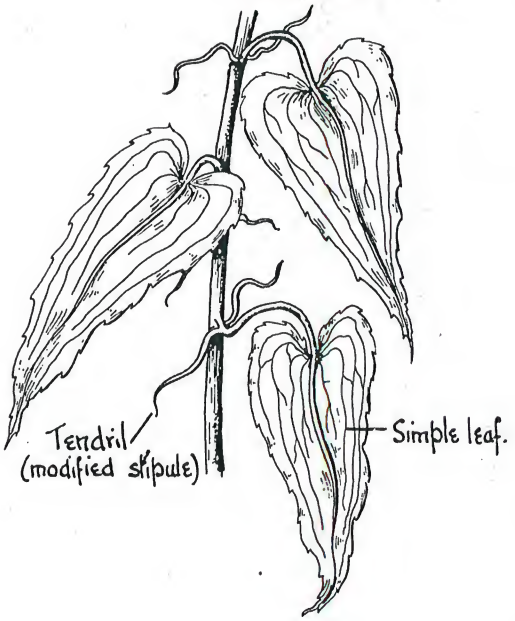
a) Yellow Pea (Lathyrus Aphaca)



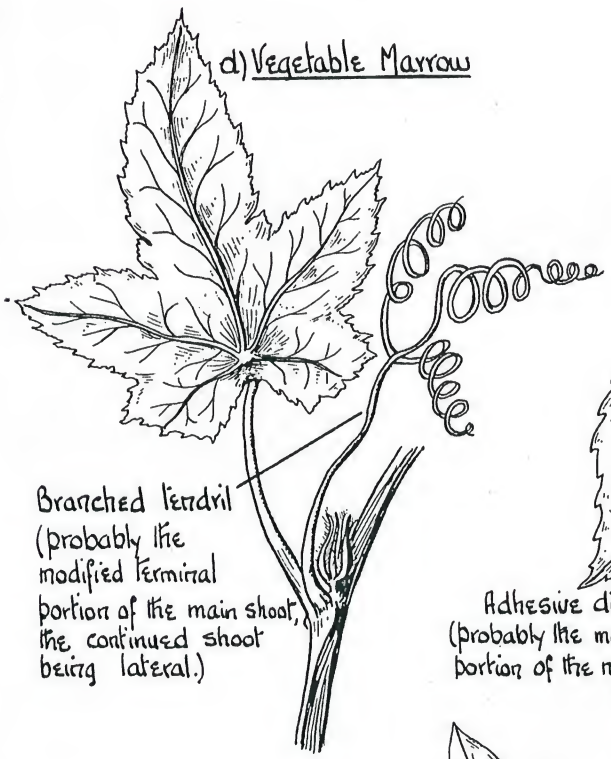
b) Sweet Pea.



c) Smilax x 2

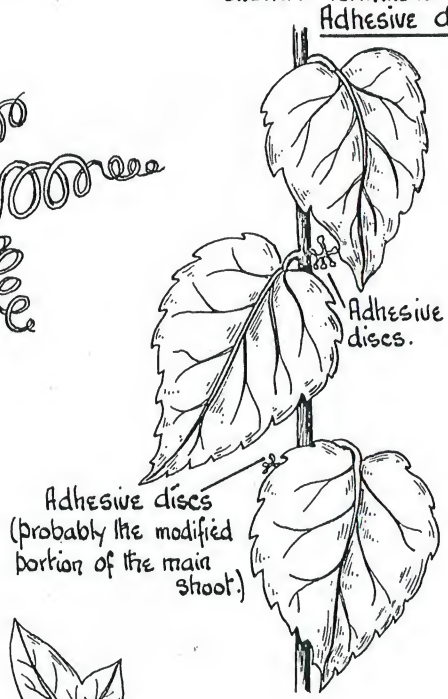


d) Vegetable Marrow

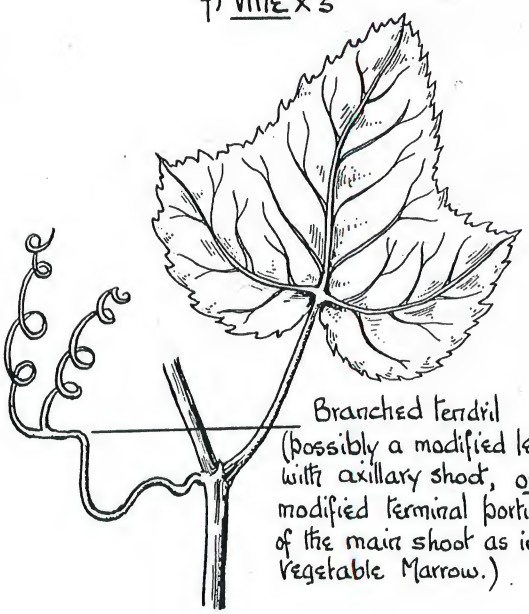


e) Virginia Creeper.

Tendrils terminate in Adhesive discs

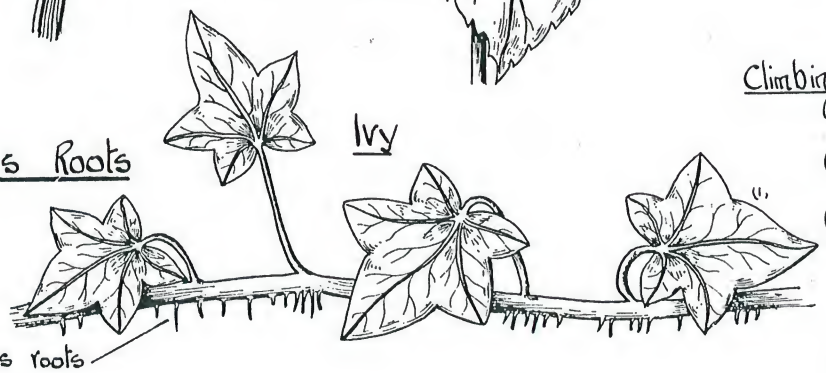


f) Vine x $\frac{1}{3}$



6. Adventitious Roots

Ivy



Climbing region.
(i) Palmately lobed leaves arranged in a leaf mosaic.
(ii) Stems bearing adventitious roots.
(iii) No inflorescences.

Above climbing region.
(i) Ovate leaves not arranged in a mosaic.
(ii) Stem devoid of adventitious roots.
(iii) With inflorescences.

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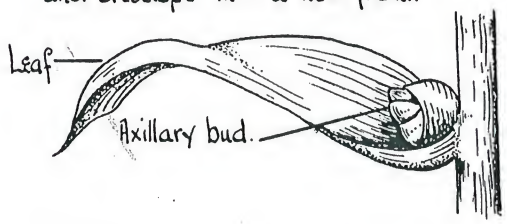
VEGETATIVE REPRODUCTION OR PROPAGATION

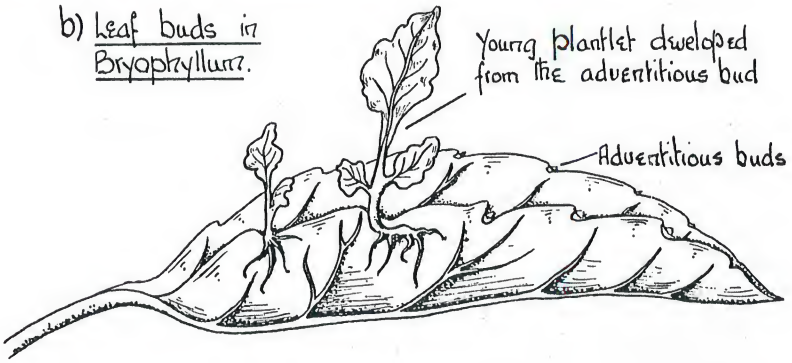
1. Bulbils and Gemmae.

a) Bulbils in Lily.

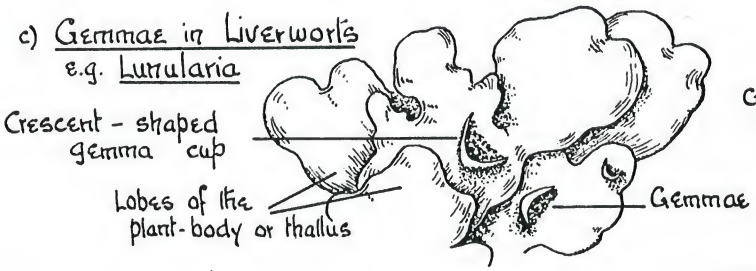
Axillary bud becomes detached, falls to the earth, and develops into a new plant.



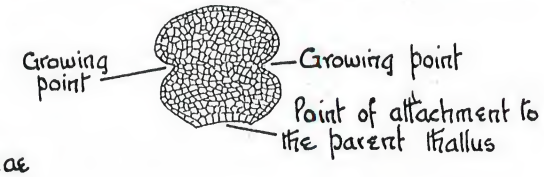
b) Leaf buds in Bryophyllum.



c) Gemmae in Liverworts e.g. Lunularia

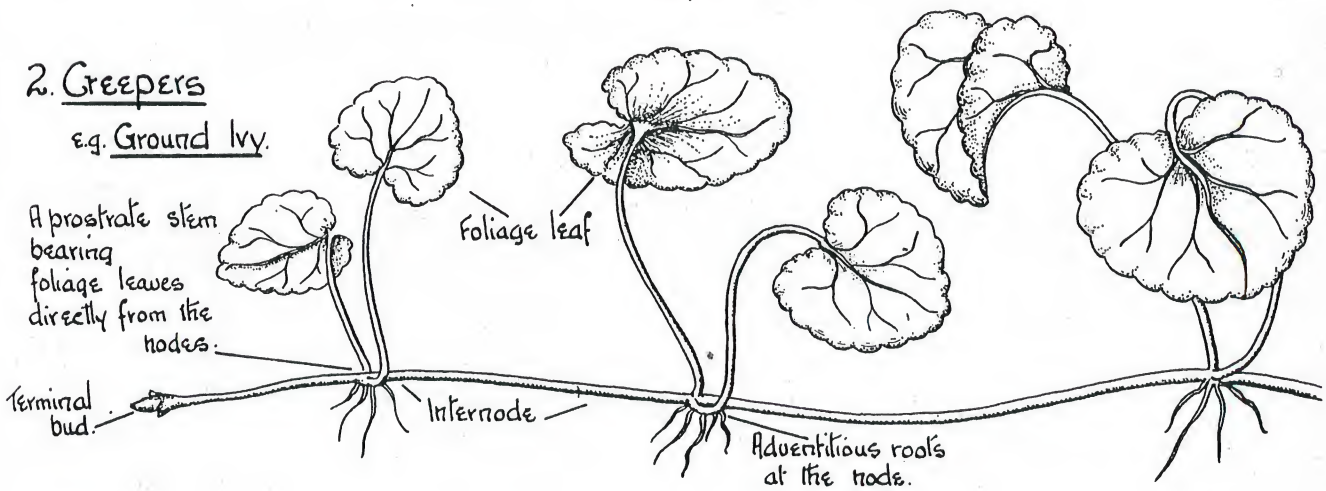


Single gemma of Lunularia x 30



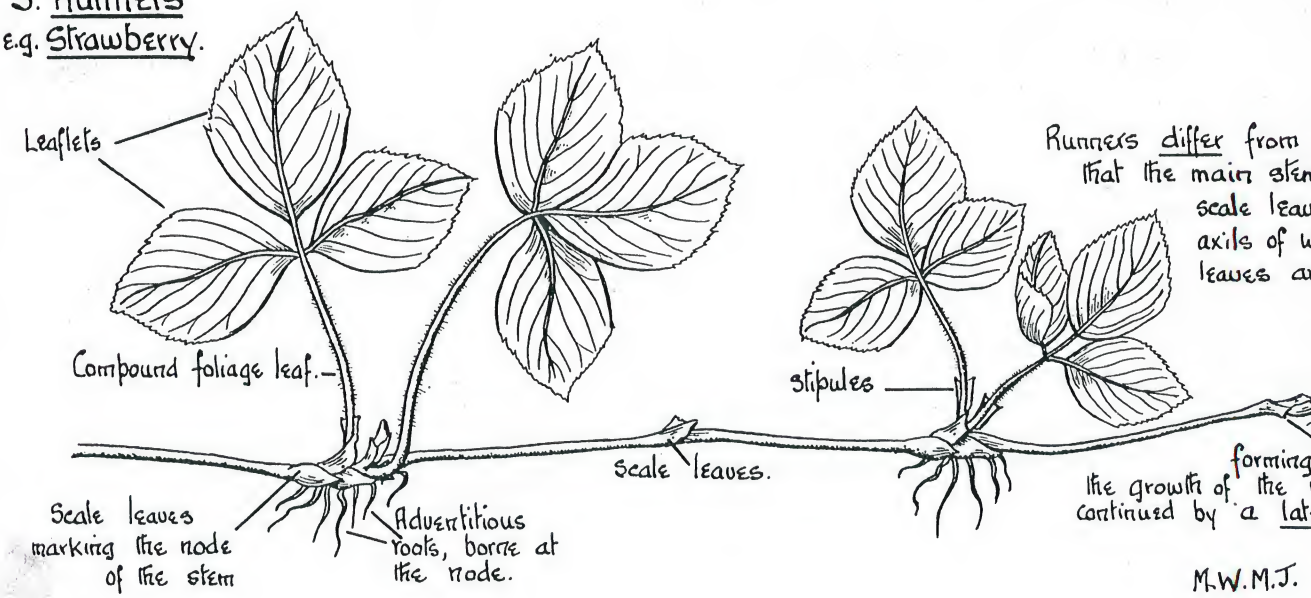
2. Creepers

e.g. Ground Ivy.



3. Runners

e.g. Strawberry.



Runners differ from creepers in that the main stem bears scale leaves in the axils of which foliage leaves arise.

The growth of the runner being continued by a lateral bud.

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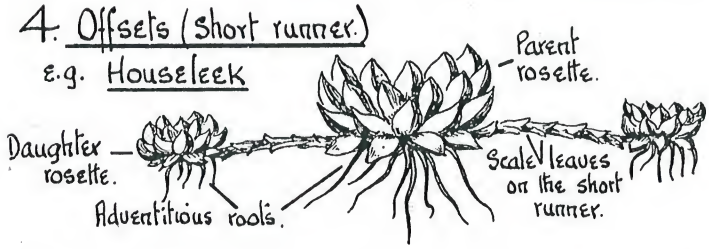
VEGETATIVE REPRODUCTION (continued)

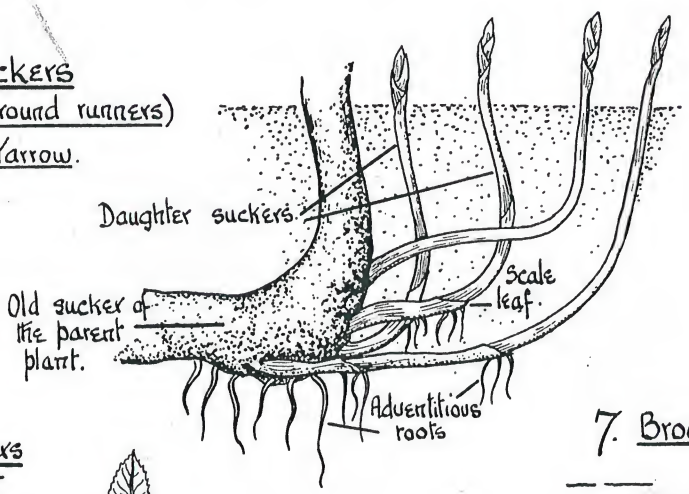
4. Offsets (Short runner.)

e.g. Houseleek

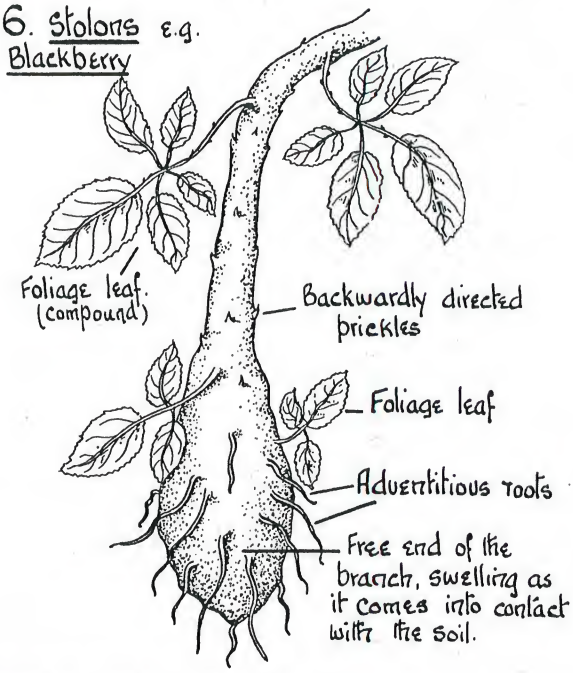


5. Suckers (Underground runners)

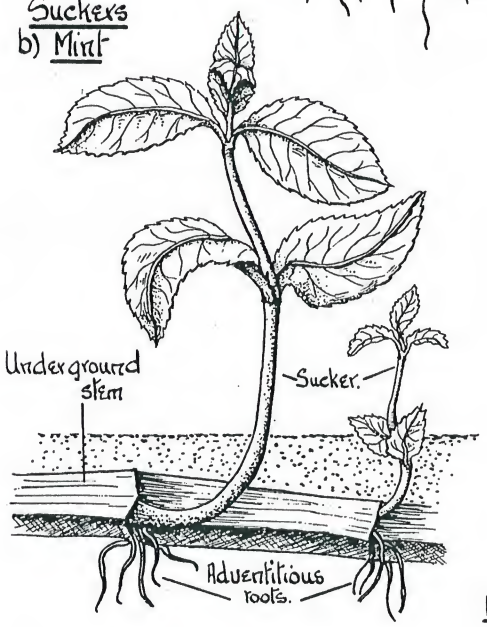
e.g. Yarrow.



6. Stolons e.g. Blackberry

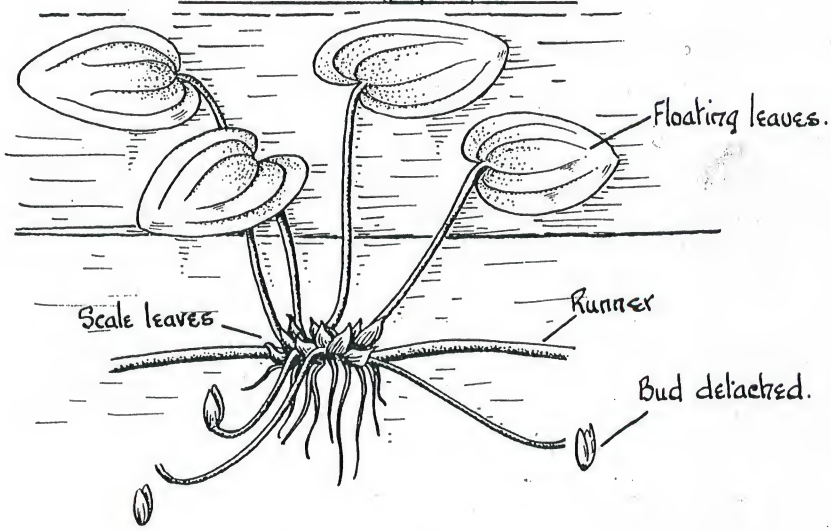


Suckers b) Mint



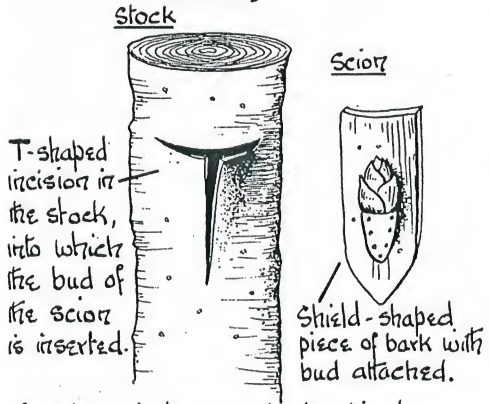
7. Brood or Winter buds - e.g. Frogbit

From Bevis and Jeffery - after Kerner.



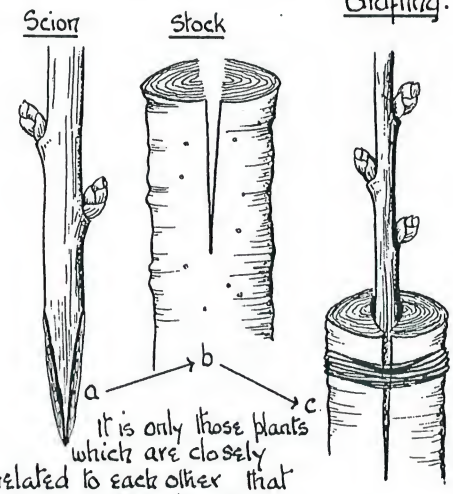
ARTIFICIAL PROPAGATION

Budding

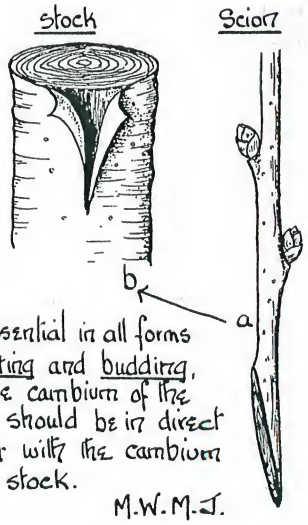


Budding is particularly practiced in rose, peach and plum cultivation

Grafting.



It is only those plants which are closely related to each other that can be grafted together.



It is essential in all forms of grafting and budding, that the cambium of the scion should be in direct contact with the cambium of the stock.

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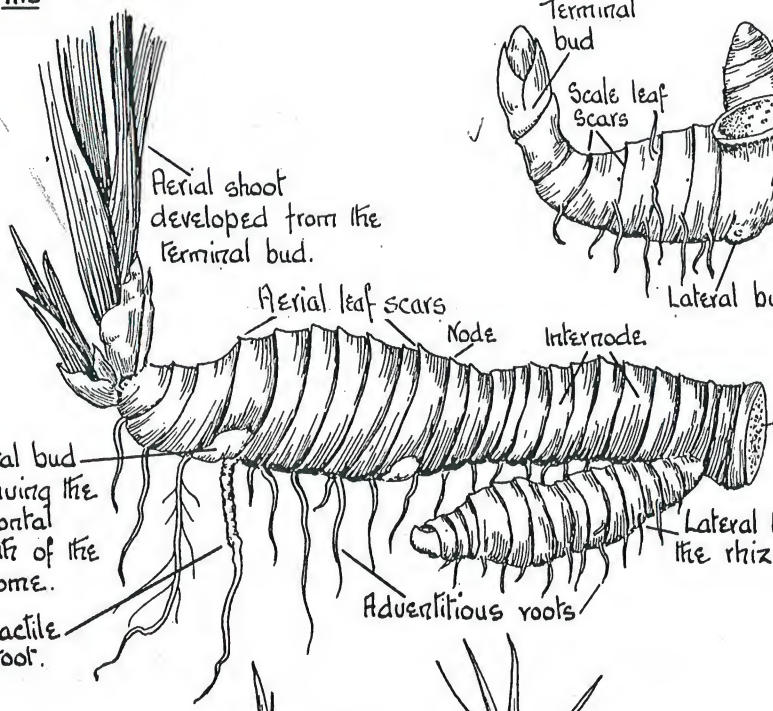
STORAGE OF FOOD MATERIAL

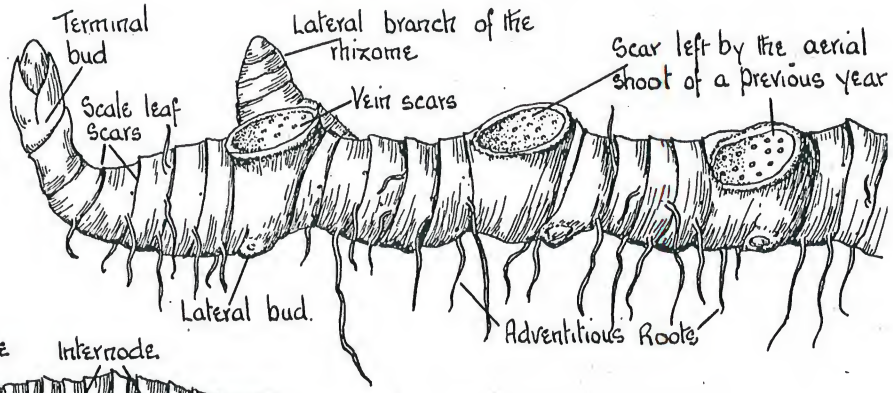
1. STEMS

a) Rhizomes

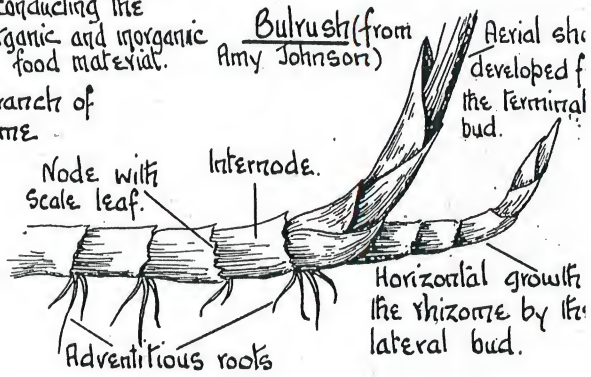
Iris



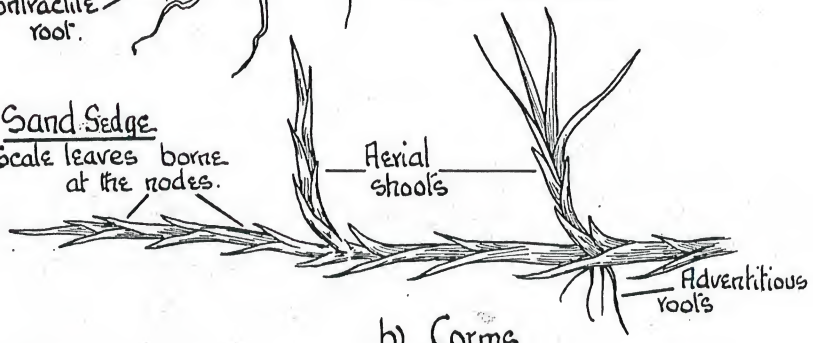
Solomon's Seal.



Bulrush (from Amy Johnson)



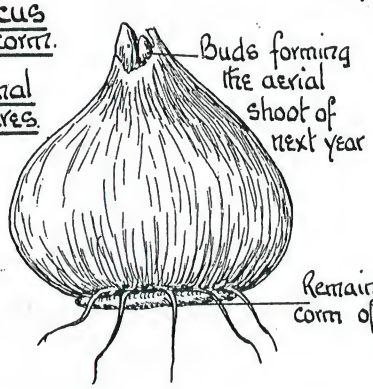
Sand Sedge



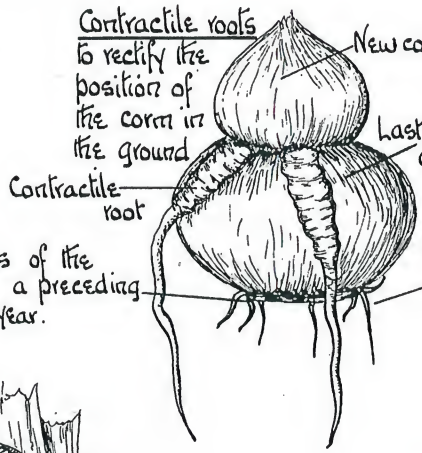
b) Corms

Crocus corm.

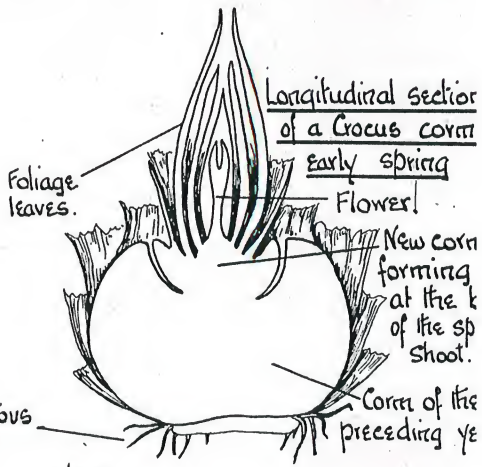
External features.



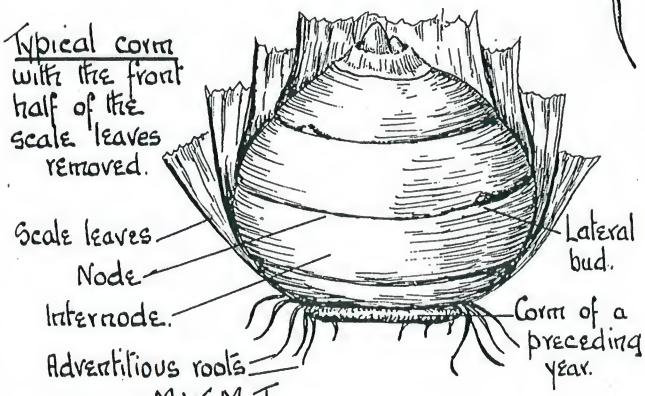
Contractile roots to rectify the position of the corm in the ground



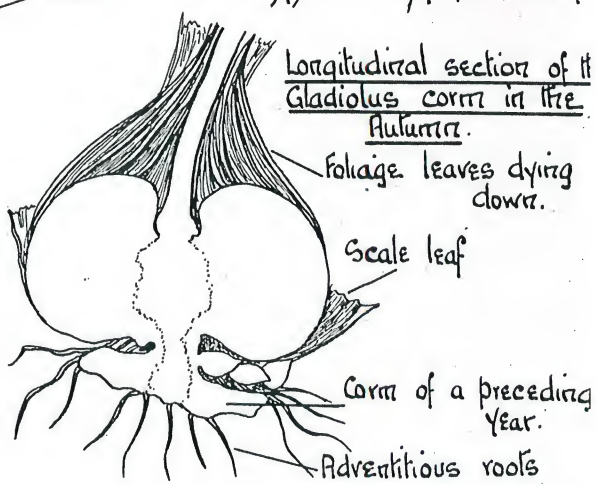
Longitudinal section of a Crocus corm early spring



Typical corm with the front half of the scale leaves removed.



Longitudinal section of th Gladiolus corm in the Autumn.



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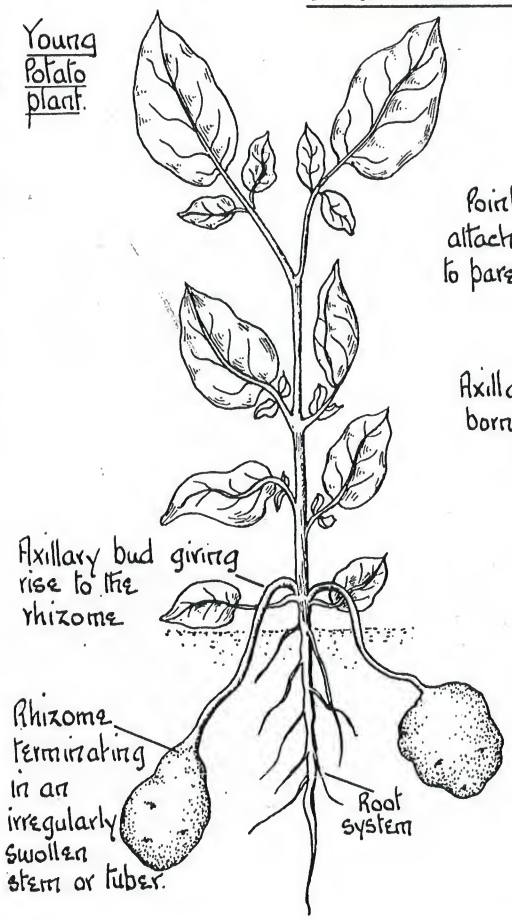
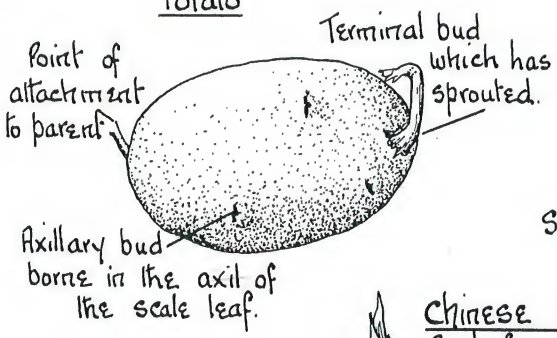
STORAGE OF FOOD MATERIAL (continued)

STEMS c) Tubers.

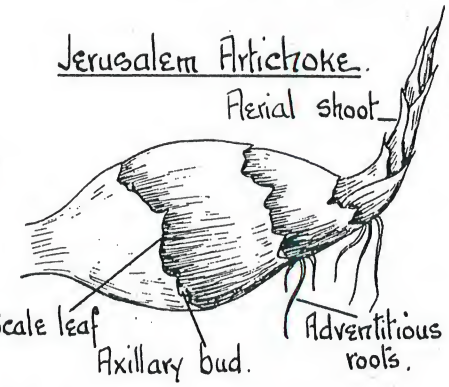
Young Potato plant.



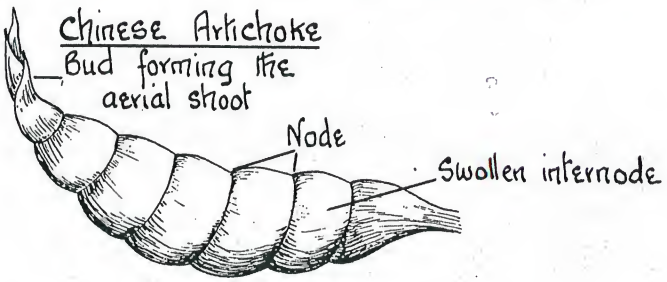
Potato



Jerusalem Artichoke.

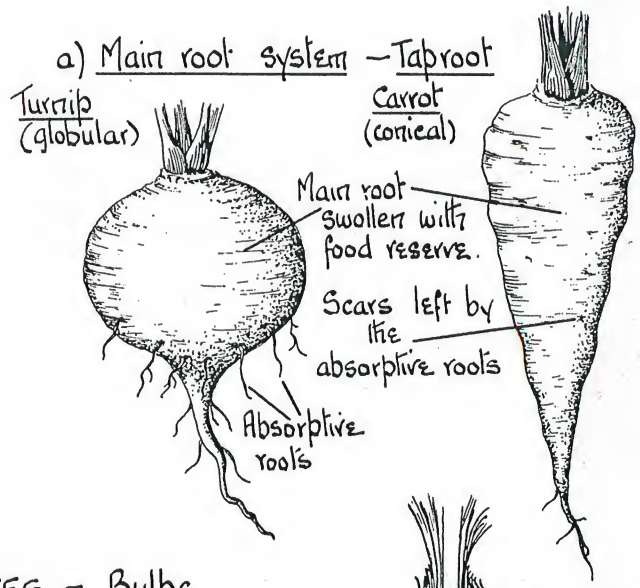


Chinese Artichoke

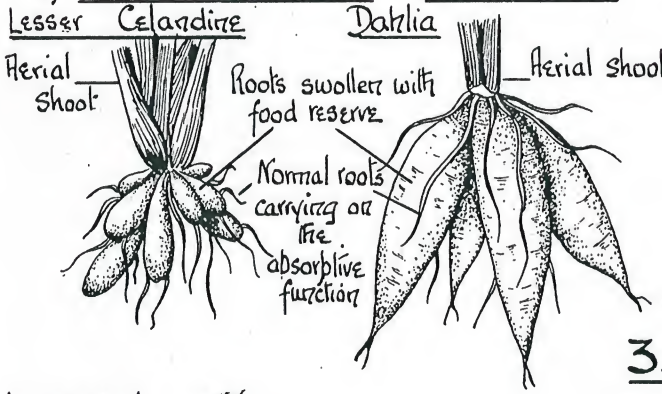


2. ROOTS.

a) Main root system – Taproot

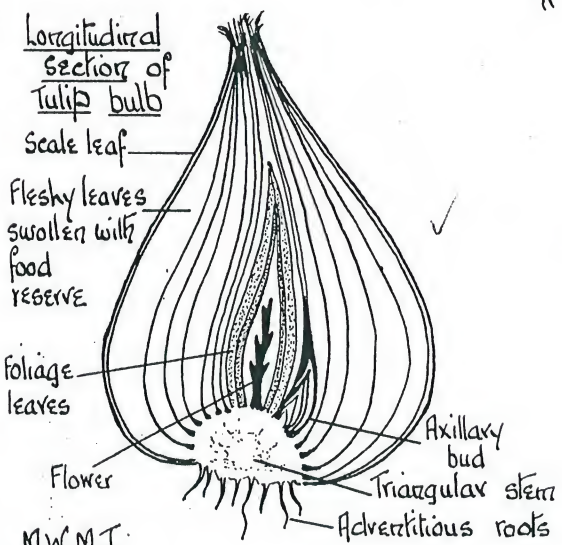


b) Fibrous root system - Tuberous roots

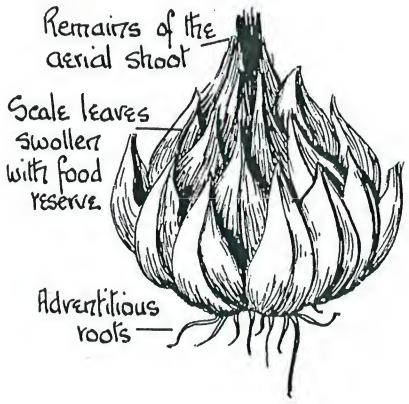


3. LEAVES - Bulbs.

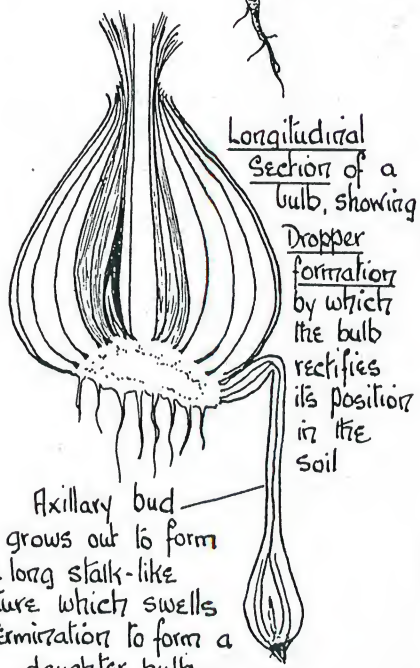
Longitudinal Section of Tulip bulb



Scaly bulb of Lily



Longitudinal Section of a bulb, showing Dropper formation by which the bulb rectifies its position in the soil



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26. FLOWER STRUCTURE. a) INFLORESCENCE.

Inflorescence. Arrangement of the flowers upon the stem.

Solitary - a) Terminal e.g. Tulip. b) Axillary e.g. Yellow Pimpernel.

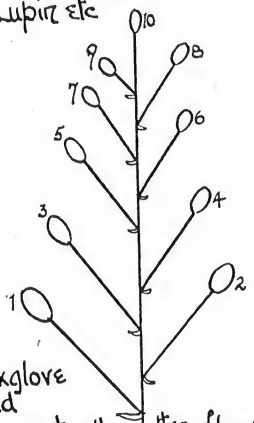
Compound a) **Racemose** - Monopodial branching; Flowers opening from below, upwards. Oldest flower at the base.

b) **Cymose** - Sympodial branching; Flowers opening from above, downwards. Youngest flower at the base.

a) RACEMES

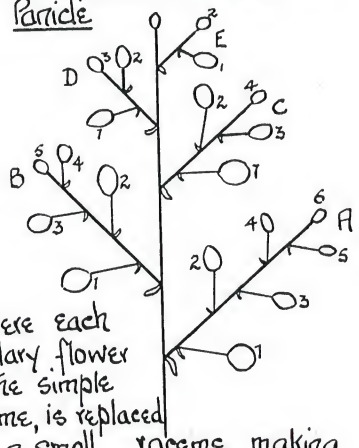
I Simple Raceme.

e.g. Lupin etc



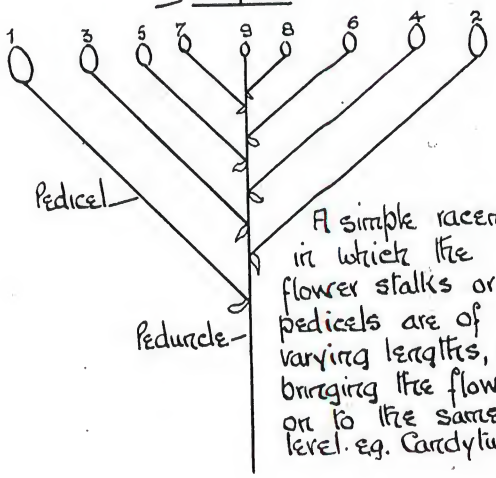
In Foxglove and Toothwort all the flowers are twisted to one side.

II Compound Raceme or Panicle



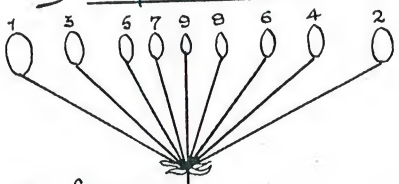
Here each axillary flower of the simple raceme, is replaced by a small raceme, making the compound structure. eg. Grasses, Yucca etc.

III Corymb.



A simple raceme in which the flower stalks or pedicels are of varying lengths, so bringing the flowers on to the same level. eg. Candytuft etc

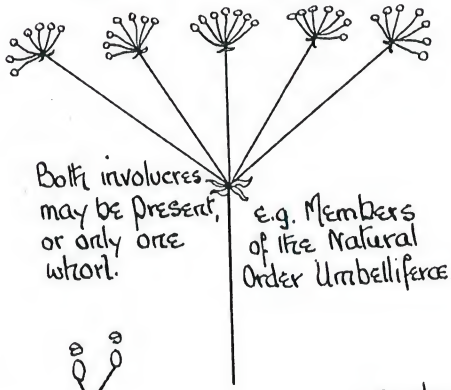
IV Simple Umbel



Here the flower-bearing portion of the main axis of the corymb is telescoped, so bracts all arise point, forming an e.g. Primrose, that the from one involucre. Cowslip etc.

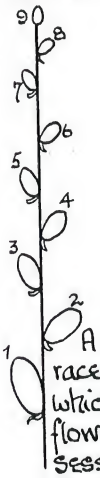
V Compound Umbel

Each flower of the simple umbel is replaced by a small umbel.



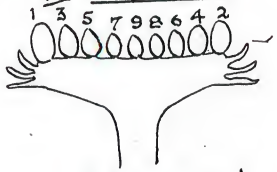
Both involucres may be present, or only one whorl. e.g. Members of the Natural Order Umbelliferae.

VI Spike



A simple raceme in which all the flowers are sessile. e.g. Hazel (male) Plantain etc.

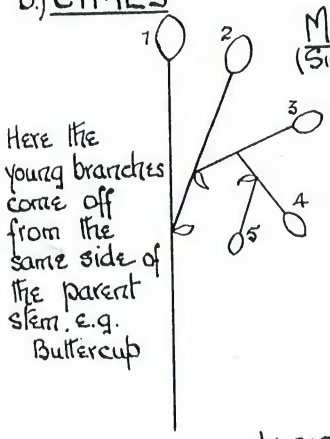
VII Capitulum



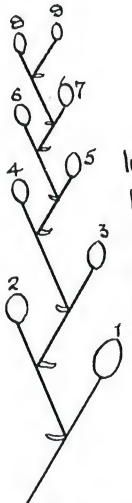
A telescoped spike - the main axis is compressed eg. Members of the Natural Order Compositae

b) CYMES

Monochasium. (Simple Cyme)

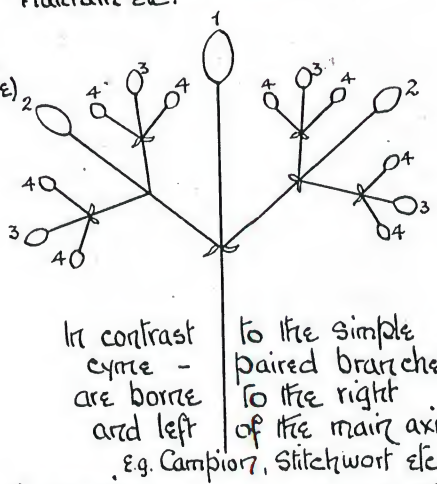


Here the young branches come off from the same side of the parent stem. e.g. Buttercup



In this case the young branches are borne on alternate sides of the parent stem. e.g. Iris

Dichasium (Double Cyme)



In contrast to the simple cyme - paired branches are borne to the right and left of the main axis. e.g. Campion, Stitchwort etc

In each case, the small numbers indicate the order of opening.

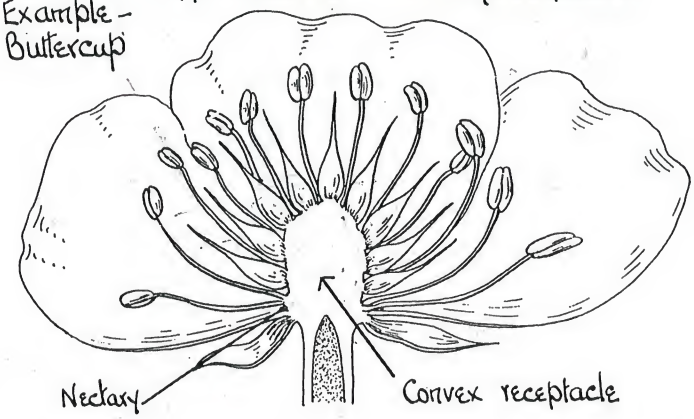
M.W.M.J.

FLOWER STRUCTURE - b) RECEPTACLE

Diagrammatic Longitudinal Sections.

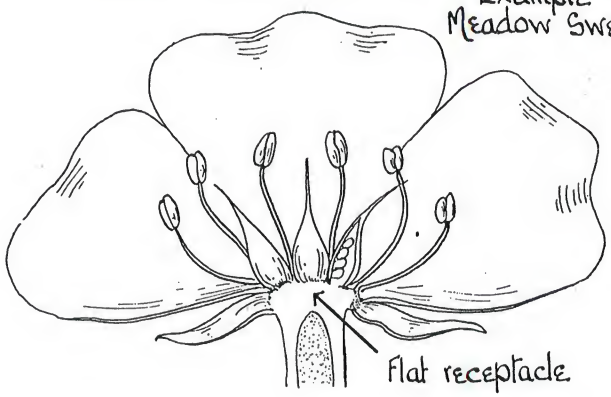
Receptacle convex;
Flower hypogynous ; Ovary superior.

Example - Buttercup

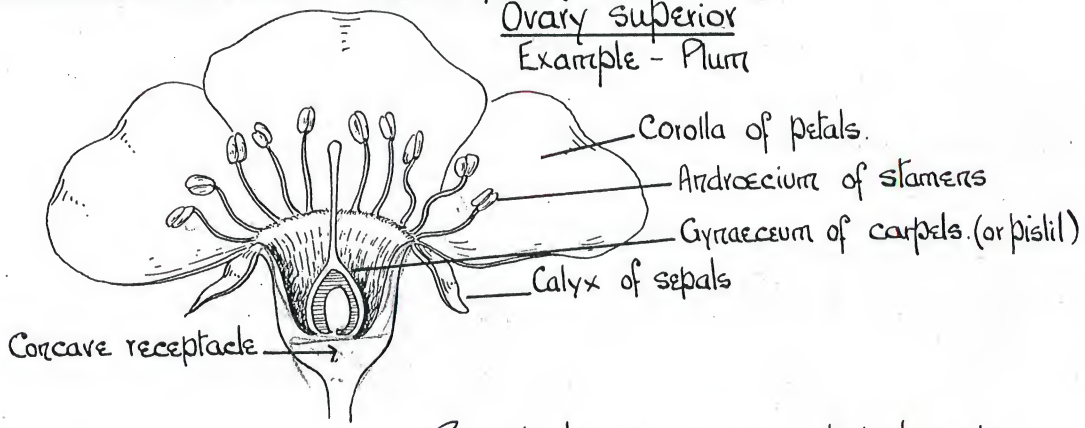


Receptacle flat;
Flower hypogynous; Ovary superior.

Example - Meadow Sweet.

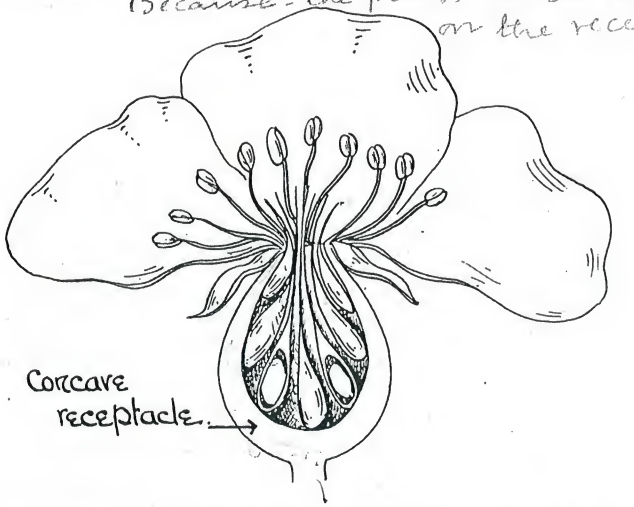


Receptacle concave ; Flower perigynous;
Ovary superior
Example - Plum

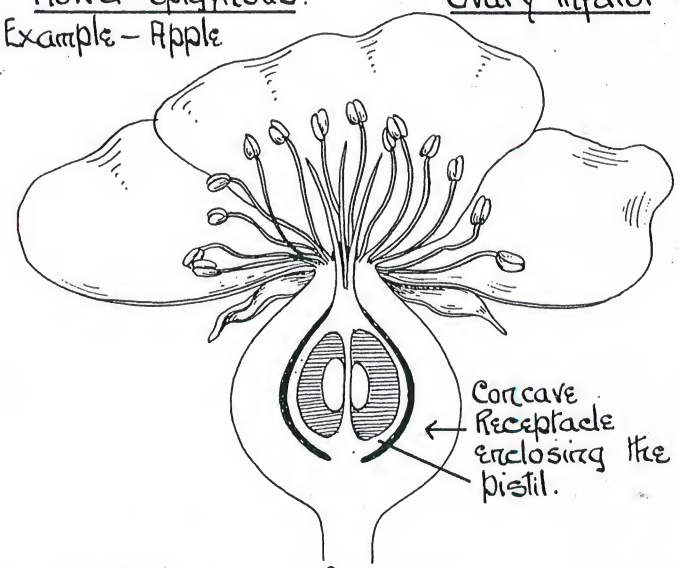


Receptacle very concave;
Flower perigynous; Ovary superior.
Example - Rose

Because the parts are borne on the receptacle.



Receptacle so concave that it meets across the top, enclosing the ovary.
Flower epigynous. Ovary inferior
Example - Apple



The Ovary is superior in hypogynous and perigynous flowers.
The Ovary is inferior in all epigynous flowers.

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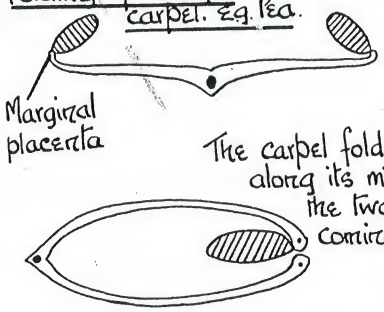
28. FLOWER STRUCTURE c) OVARY AND PLACENTATION

Ovary. I Apocarpous (carpels free from each other) Examples:-
Collection of Follicles; Collection of Achenes; Collection of Drupels.

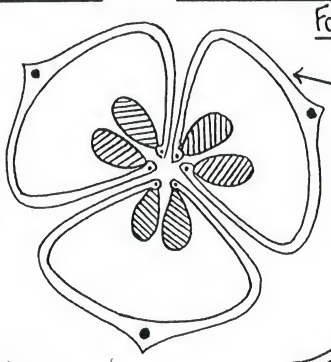
II Syncarpous (carpels joined together.)
a) Locular (each carpel folded before the adjacent sides fuse)
b) Unilocular (edges of the adjacent carpels fuse.)

Locular ovaries - Placentation axile.

Folding of a single carpel. Eg. Pea.

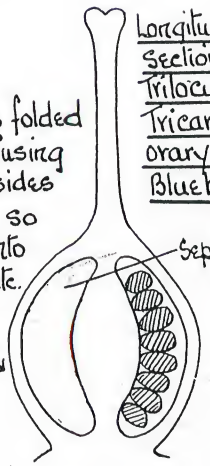


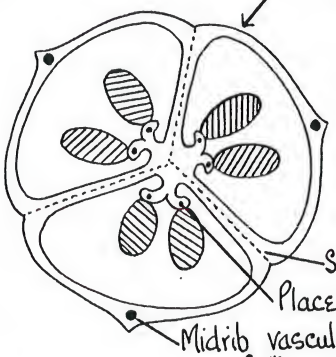
Formation of Trilocular Tricarpellary ovary.



Here each carpel is folded along its midrib before fusing with the corresponding sides of the adjacent carpels, so carrying the placentas into the centre. e.g. Bluebell etc.

Longitudinal section of the Trilocular Tricarpellary ovary - eg. Bluebell etc

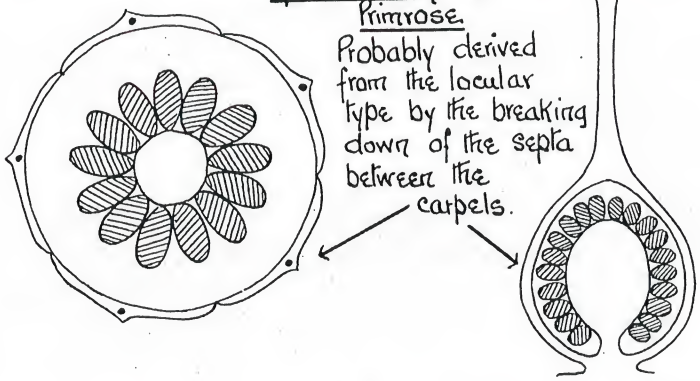




Transverse section of the Trilocular Tricarpellary ovary. eg. Bluebell etc.

Unilocular ovaries - Placentation free-central.

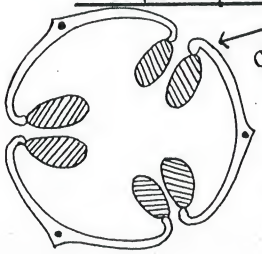
Transverse section and Longitudinal section of the ovary eg. Primrose.



Probably derived from the locular type by the breaking down of the septa between the carpels.

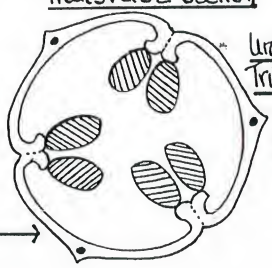
Unilocular ovaries - Placentation parietal

Formation of the Unilocular Tricarpellary ovary.

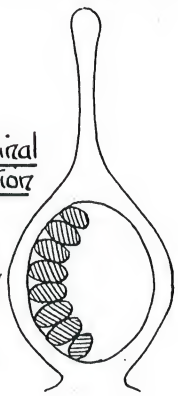


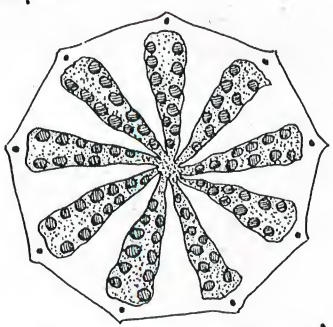
Here the constituent carpels fuse edge to edge, so that the placentas lie along the wall

Transverse section



Longitudinal section of a Unilocular Tricarpellary ovary eg. Violet



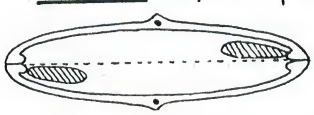


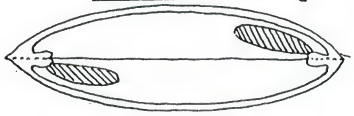
Transverse section of a Unilocular Multicarpellary ovary - e.g. Poppy.
Here the parietal placenta project well into the interior of the ovary.

Formation of False Septa.

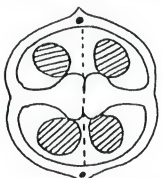
Relatively late in the development of the ovary a false septum or replum arises. — e.g. Cruciferae

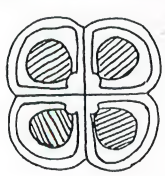
Here the bicarpellary unilocular ovary becomes bilocular by the formation of a false septum or replum - the resulting fruit being either a silicula or siliqua according to its shape.





Labiatae and Boraginaceae





Here the bicarpellary bilocular ovary becomes quadrilocular by the formation of a false septum, the resulting fruit being a schizocarp of four nutlets.

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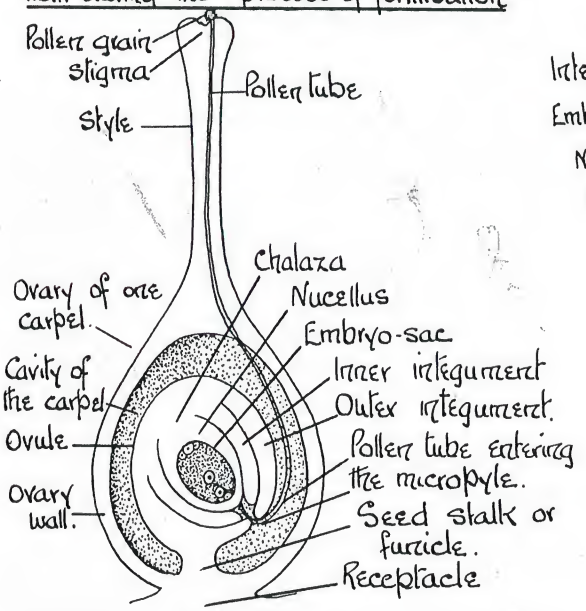
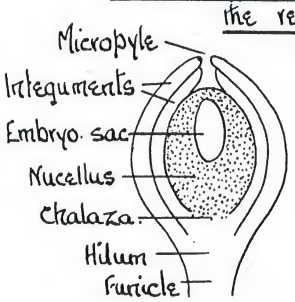
FLOWER STRUCTURE d) PISTIL AND STAMENS

Pistil or Gynaeceum of Carpels.

Diagrammatic longitudinal section of the Pistil during the process of fertilisation

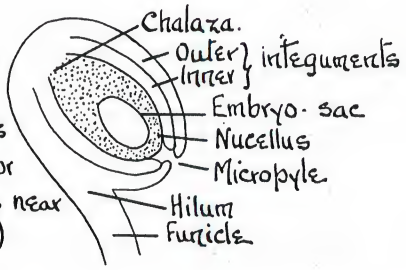


Various types of Ovules – the variation depending upon the relative arrangement of the parts.

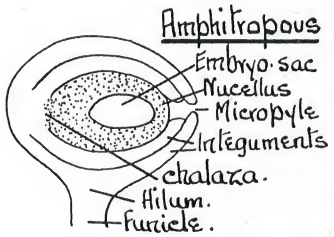


Atropous or Orthotropous
When the longitudinal axis of the nucellus, is a direct continuation of the funicle, (or when the funicle, chalaza and micropyle are in one straight line)

Anatropous
When the funicle is sharply curved below the chalaza, so that the ovule is bent back along its stalk (or when the micropyle comes near to the placenta.)

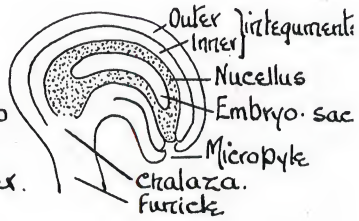


Amphitropous

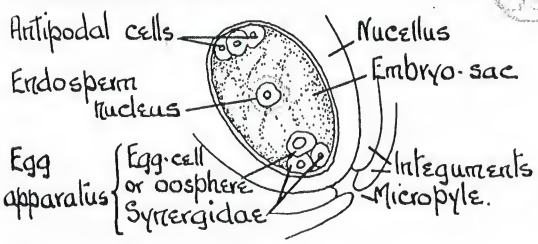


When the longitudinal axis of the ovule is at rightangles to the funicle (or when the chalaza and micropyle are in a line at rightangles to the funicle.)

Campylotropous
When the ovule is bent upon itself, and not upon the stalk so that the micropyle, chalaza and funicle are close together.



Embryo-sac.



Androecium of Stamens

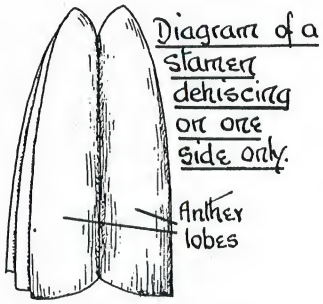
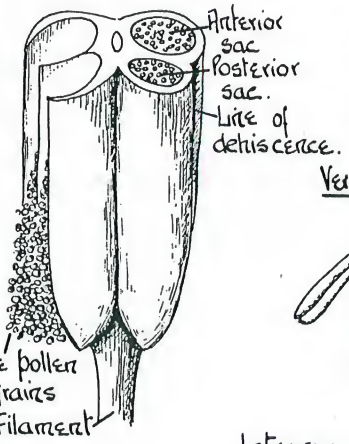
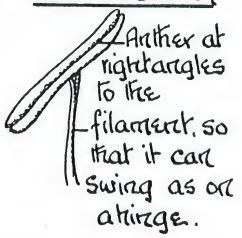


Diagram of a stamen dehiscing on one side only.

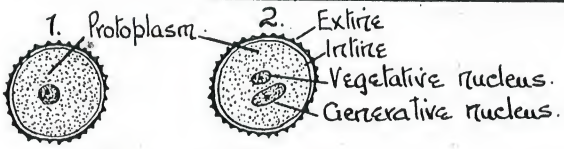
Adnate stamen

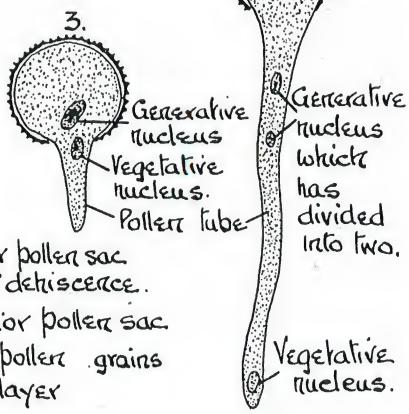


Versatile stamen

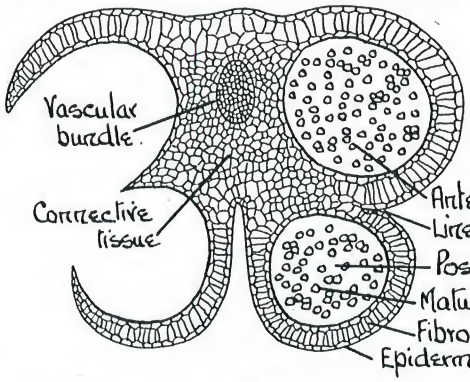


Development of the pollen grain (Microspore)





Diagrammatic transverse section showing dehiscence of one side only.

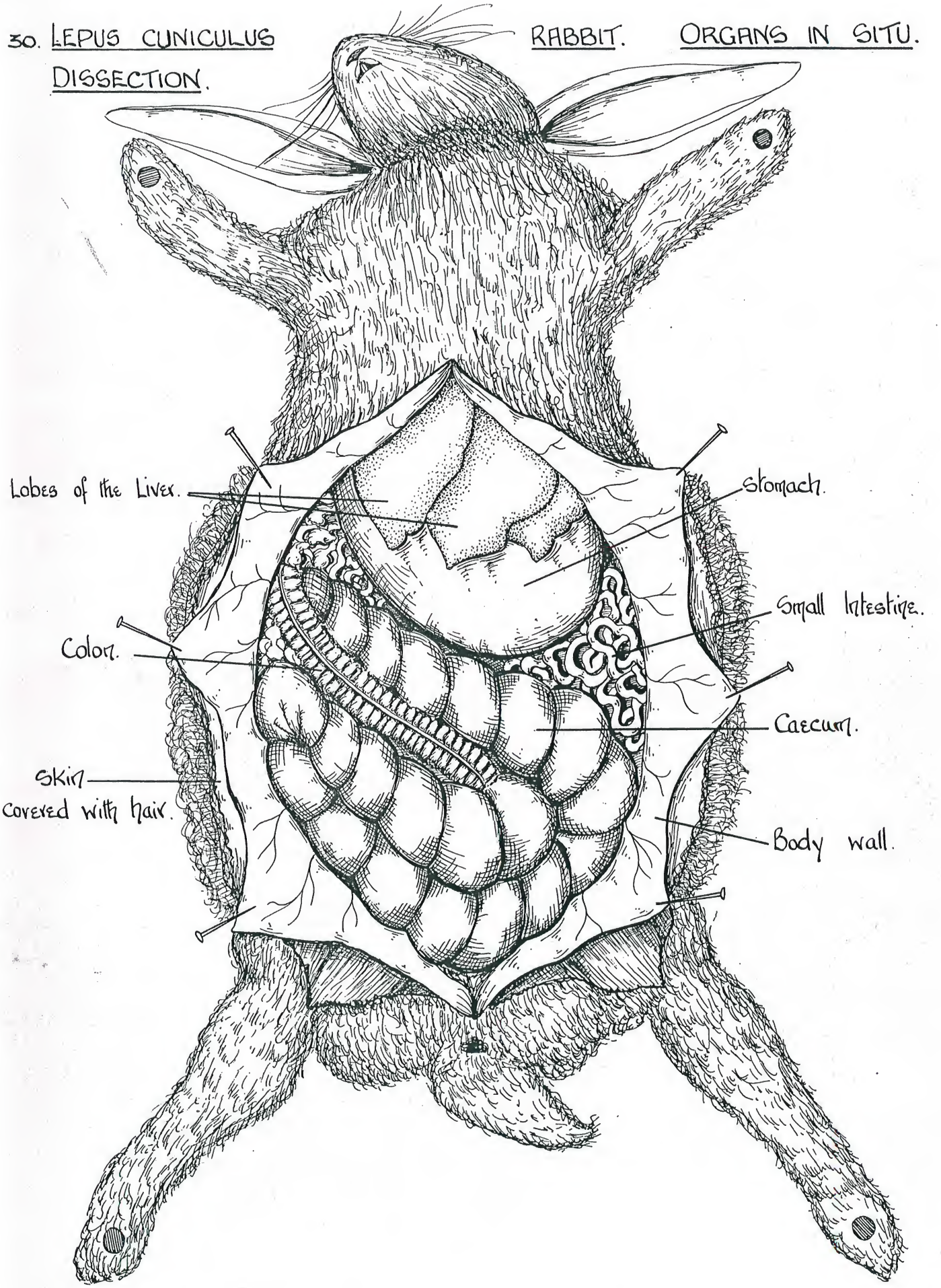


Introrse dehiscence - when the posterior pollen sacs face the Gynaeceum.
Extrorse dehiscence - when the anterior pollen sacs face the Gynaeceum.

M.W.M.J.

30. LEPUS CUNICULUS RABBIT. ORGANS IN SITU.

DISSECTION.



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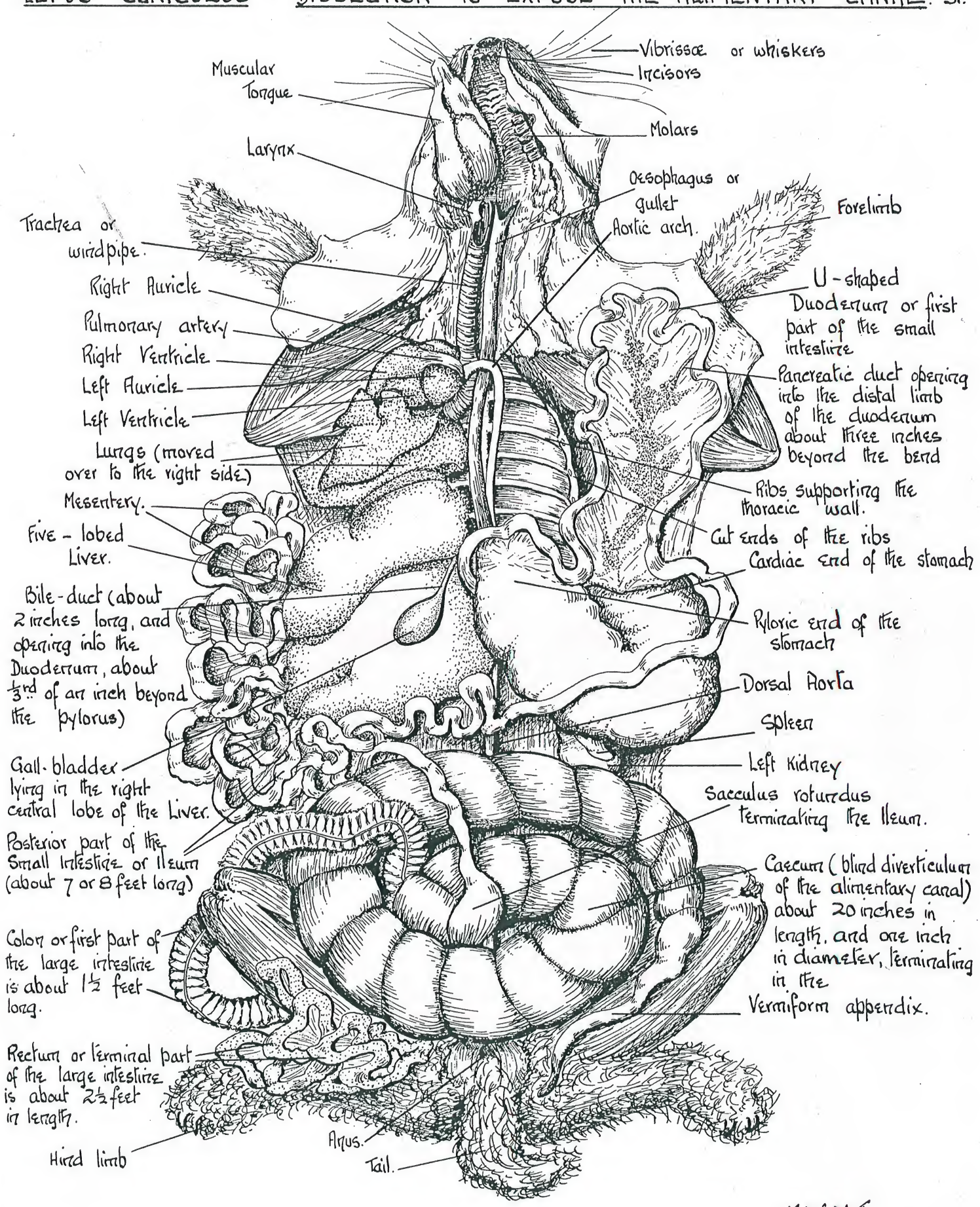
LEPUS CUNICULUS - DISSECTION TO EXPOSE THE ALIMENTARY CANAL.



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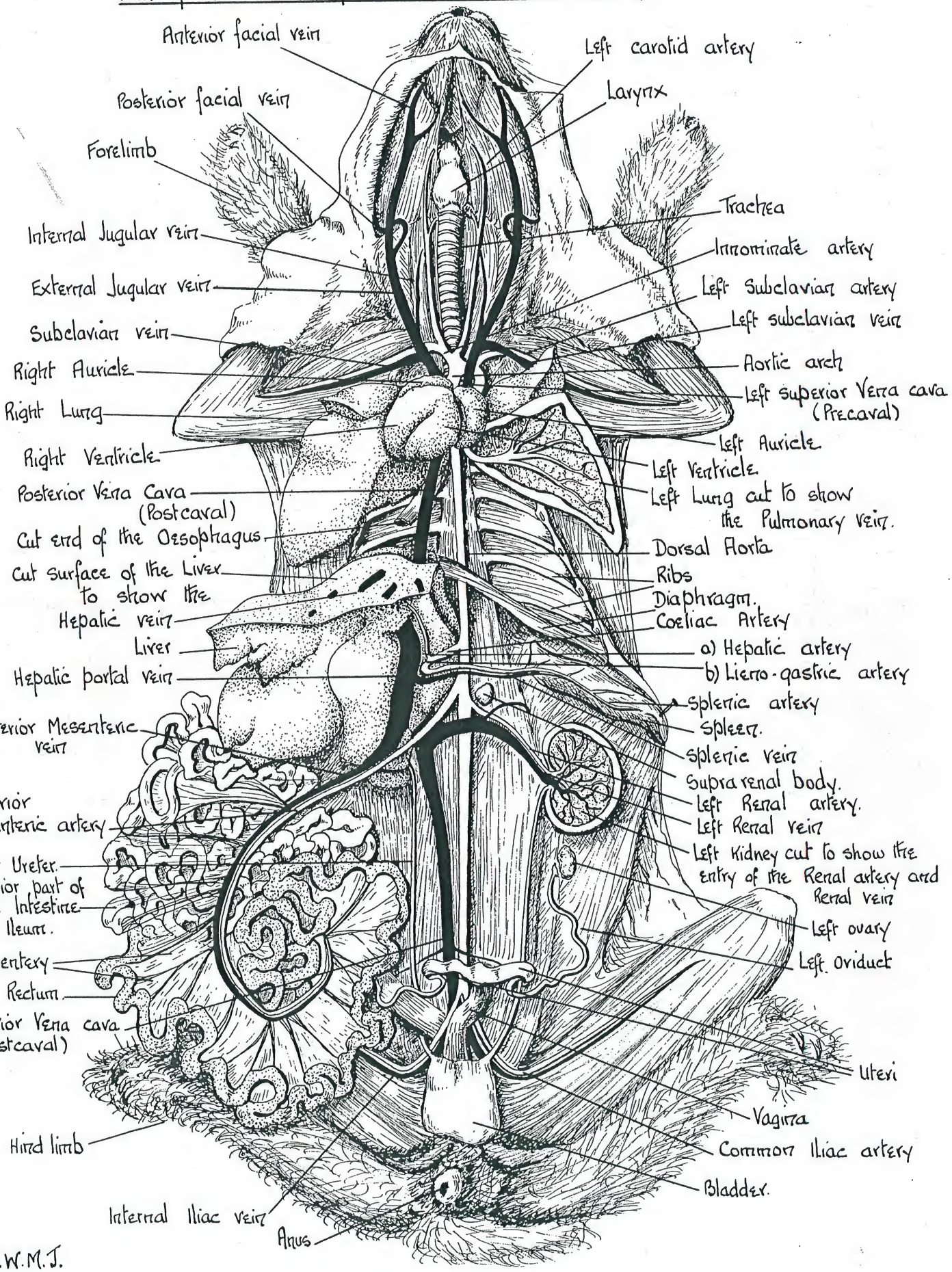
32. LEPUS CUNICULUS - DISSECTION TO SHOW THE CIRCULATORY SYSTEM.
Part of the Alimentary canal has been removed.



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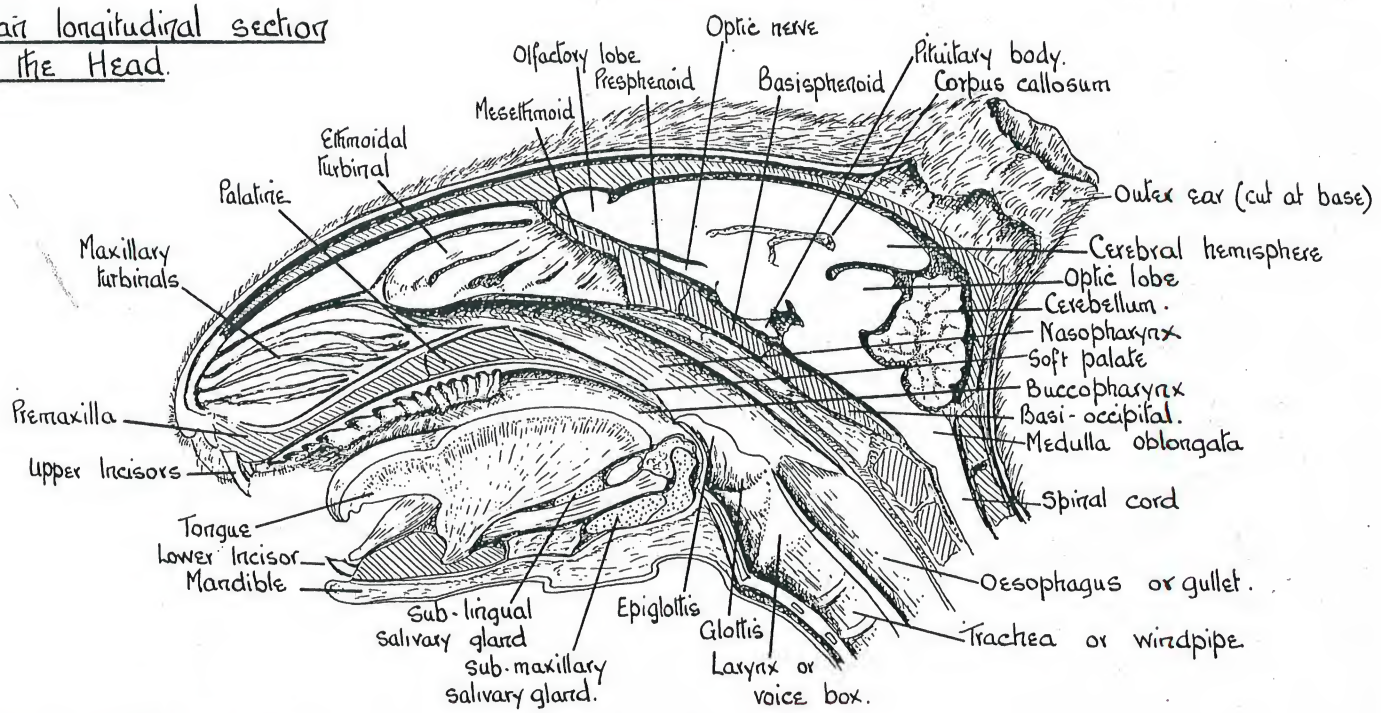
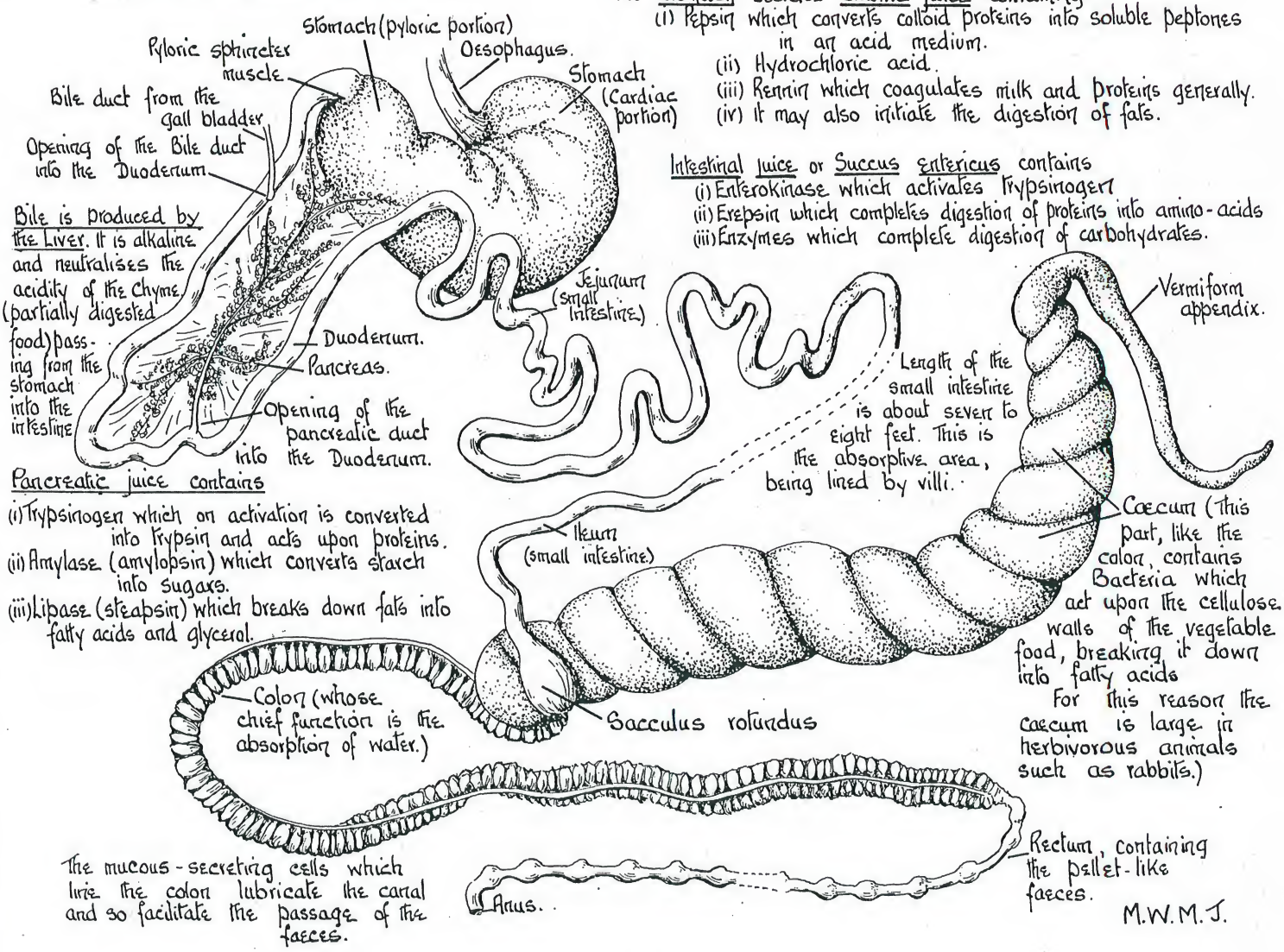
LEPUS CUNICULUS - DIGESTIVE SYSTEM.

Median longitudinal section of the Head.



ALIMENTARY CANAL.



Bile is produced by the Liver. It is alkaline and neutralises the acidity of the chyme (partially digested food) passing from the stomach into the intestine

Pancreatic juice contains

(i) Trypsinogen which on activation is converted into trypsin and acts upon proteins.
(ii) Amylase (amylopsin) which converts starch into sugars.
(iii) Lipase (steapsin) which breaks down fats into fatty acids and glycerol.

The **Stomach** secretes **Gastric juice** containing

(i) Pepsin which converts colloid proteins into soluble peptones in an acid medium.
(ii) Hydrochloric acid.
(iii) Rennin which coagulates milk and proteins generally.
(iv) It may also initiate the digestion of fats.

Intestinal juice or **Succus entericus** contains

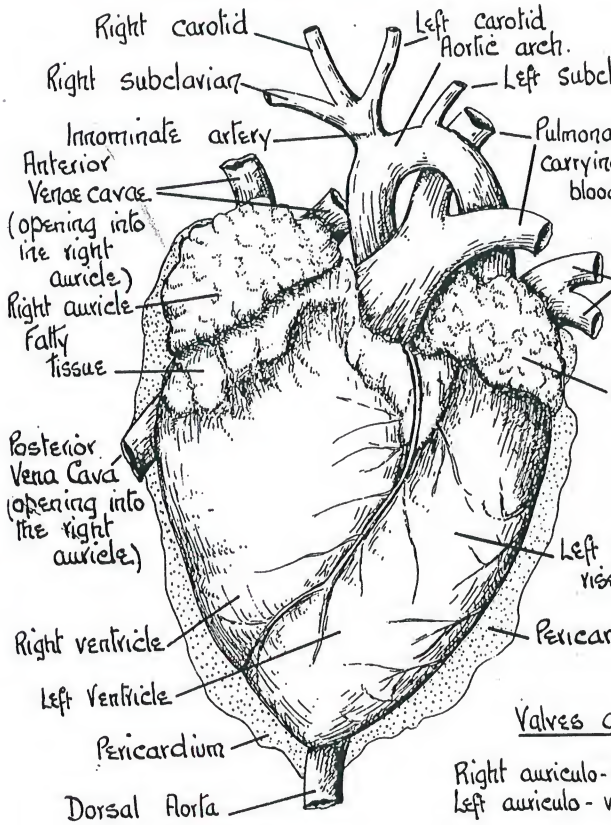
(i) Enterokinase which activates trypsinogen
(ii) Erepsin which completes digestion of proteins into amino-acids
(iii) Enzymes which complete digestion of carbohydrates.

The mucous-secreting cells which line the colon lubricate the canal and so facilitate the passage of the faeces.

M.W.M.J.

STRUCTURE OF THE MAMMALIAN HEART.

HEART OF SHEEP (Ventral Surface.)



Openings of the vessels into the Heart.

Right Auricle – 3 openings of the Venae Cavae from all parts of the body.

Left Auricle – Pulmonary vein from the lung.

Right Ventricle – Pulmonary artery to the lungs.

Left Ventricle – Aortic arch to all parts of the body.

Valves guarding the apertures.

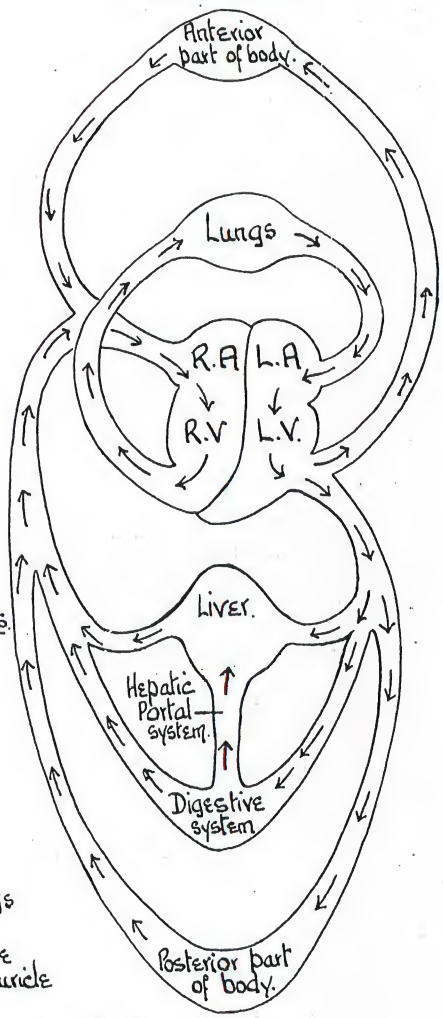
Right auriculo-ventricular aperture – Tricuspid valves.

Left auriculo-ventricular aperture – Bicuspid or Mitral valves.

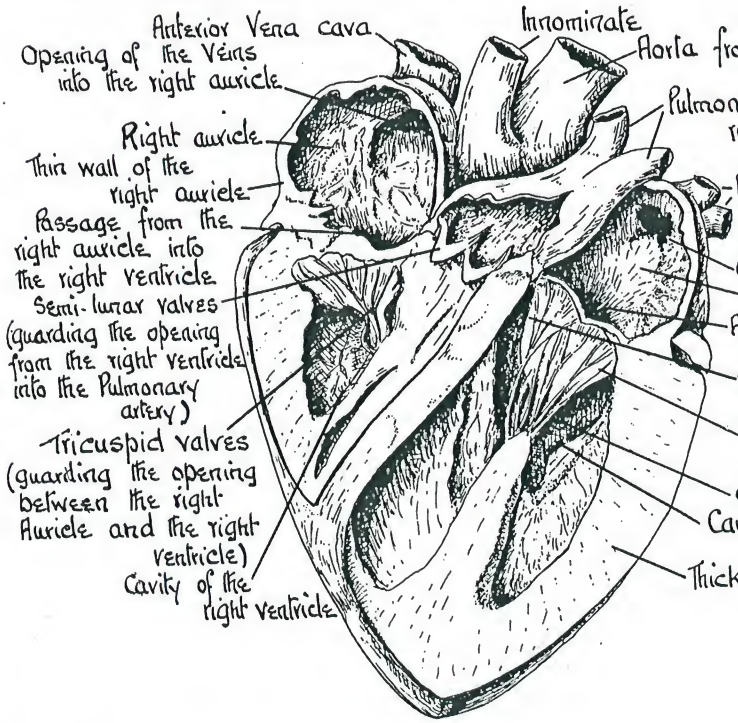
Pulmonary artery from the right ventricle – 3 semi-lunar valves.

Aorta from the left ventricle – 3 semi-lunar valves.

CIRCULATION

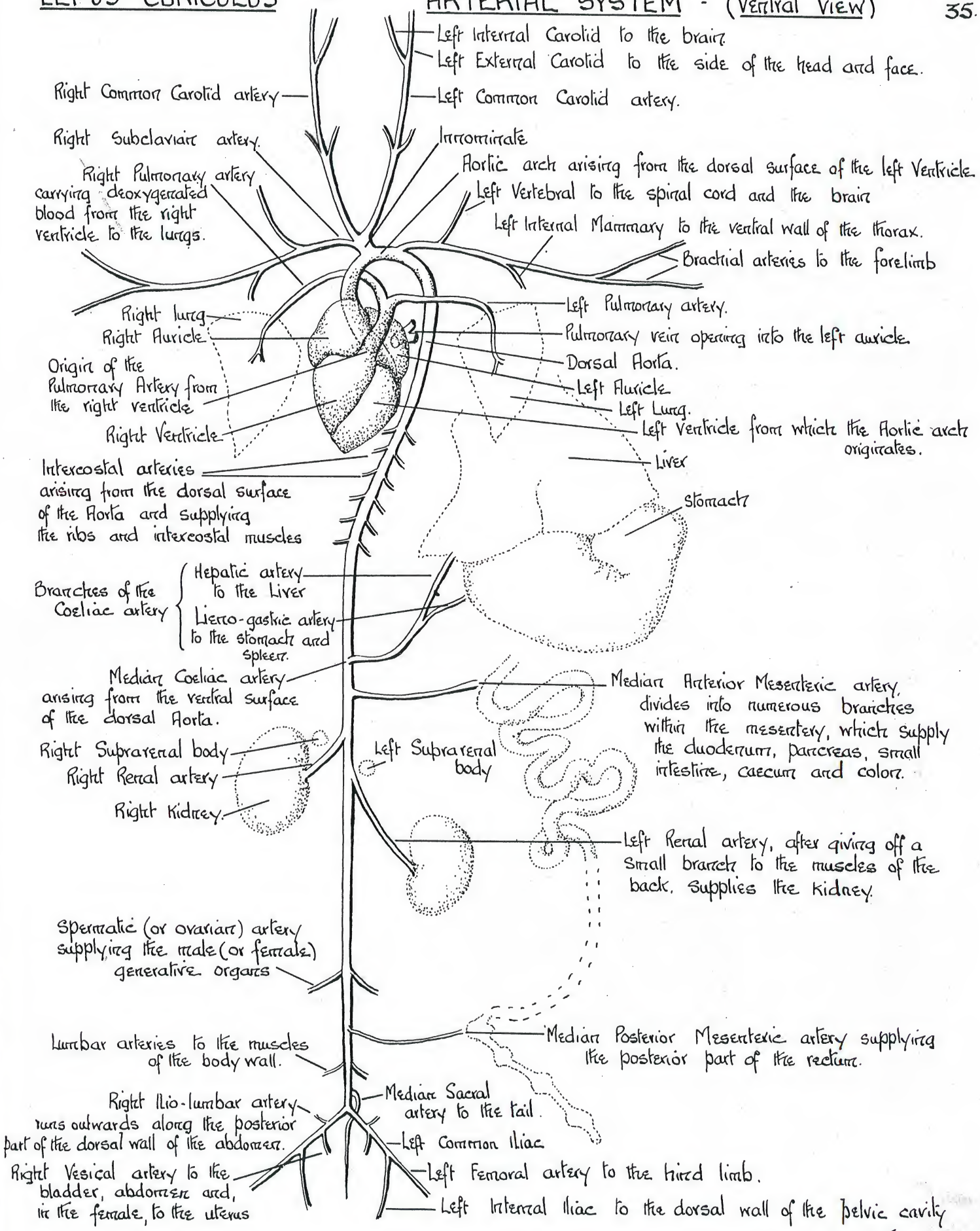


SHEEP'S HEART (Dissected from the ventral side)



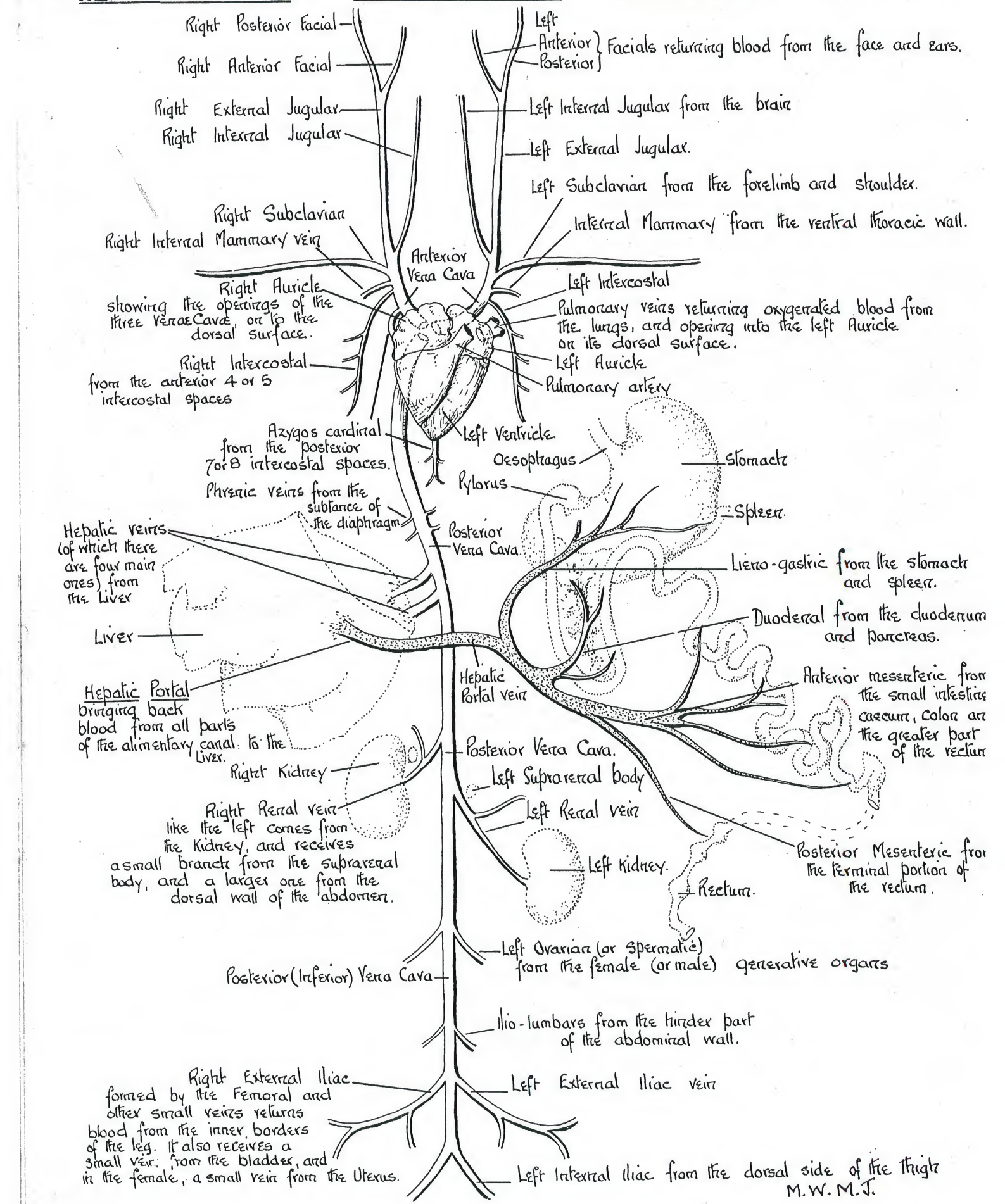
M.W.M.J.

LEPUS CUNICULUS - ARTERIAL SYSTEM - (Ventral view)



M.W.M.J.

36 LEPUS CUNICULUS - VENOUS SYSTEM. (Ventral view).

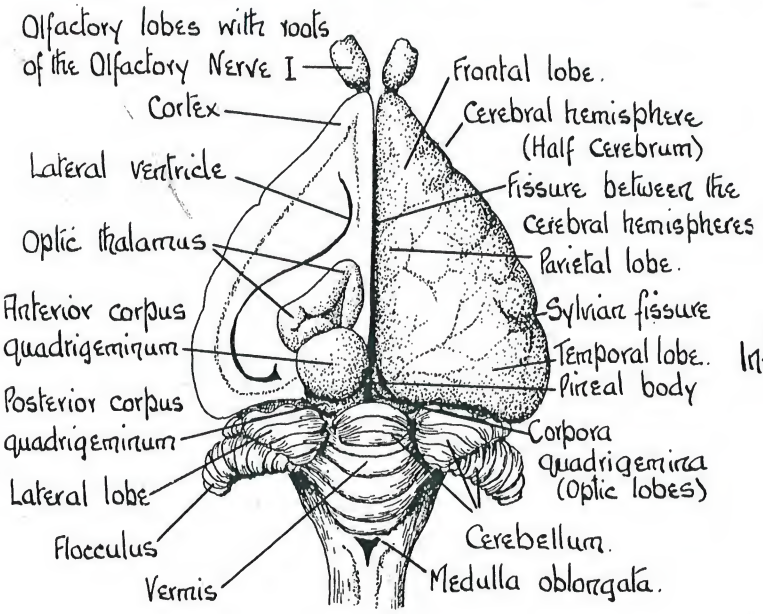


M.W.M.J.

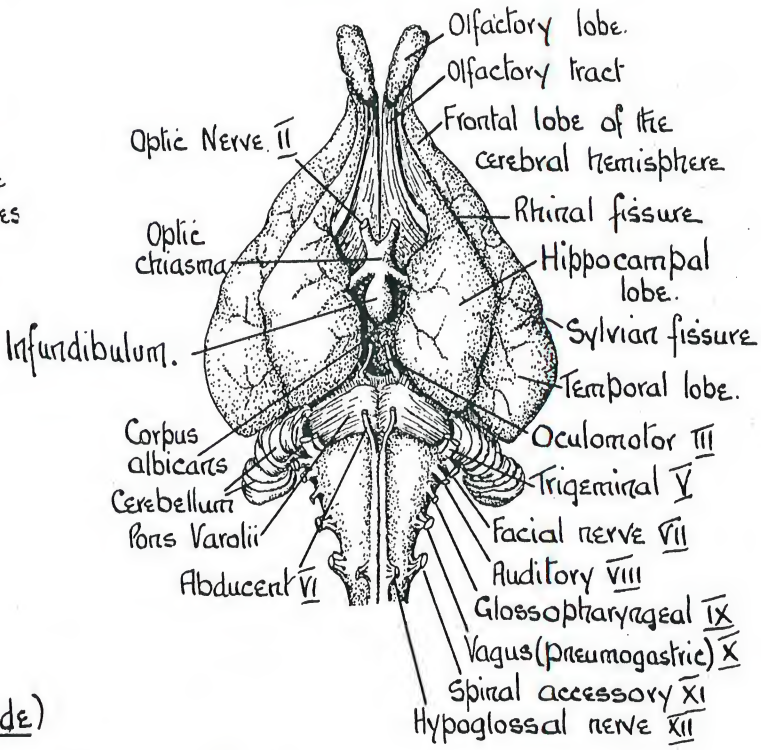
LEPUS CUNICULUS - RABBIT. NERVOUS SYSTEM.

BRAIN.

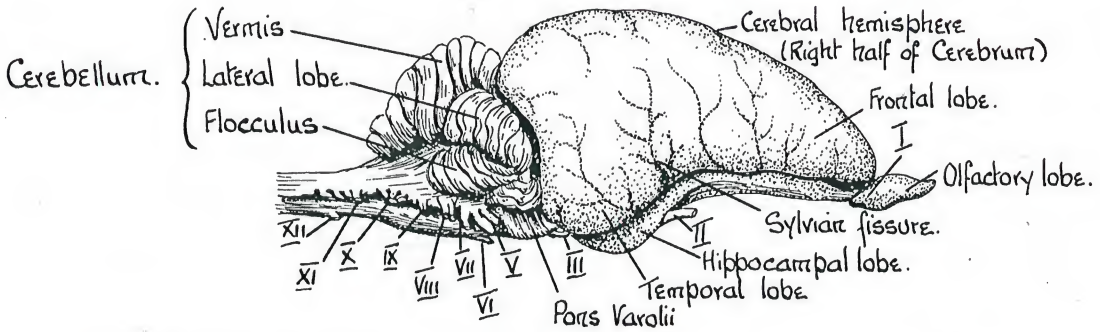
Dorsal surface. (Part of the left Cerebral hemisphere is cut away.)



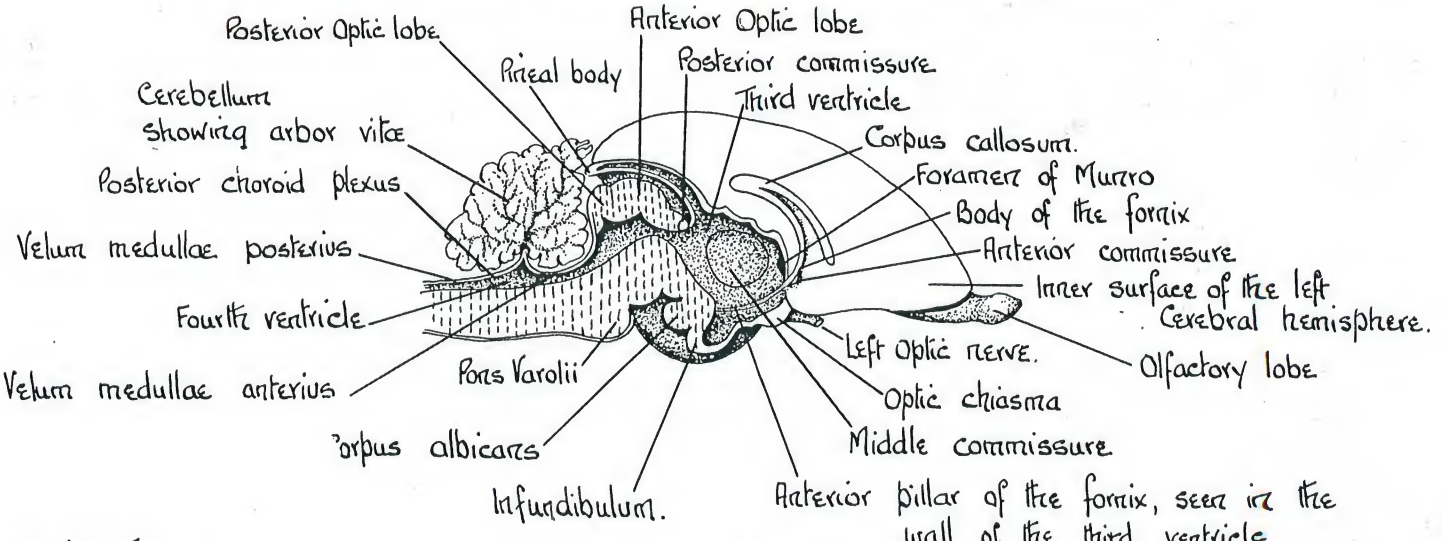
Ventral surface.



Lateral view. (from the left side)



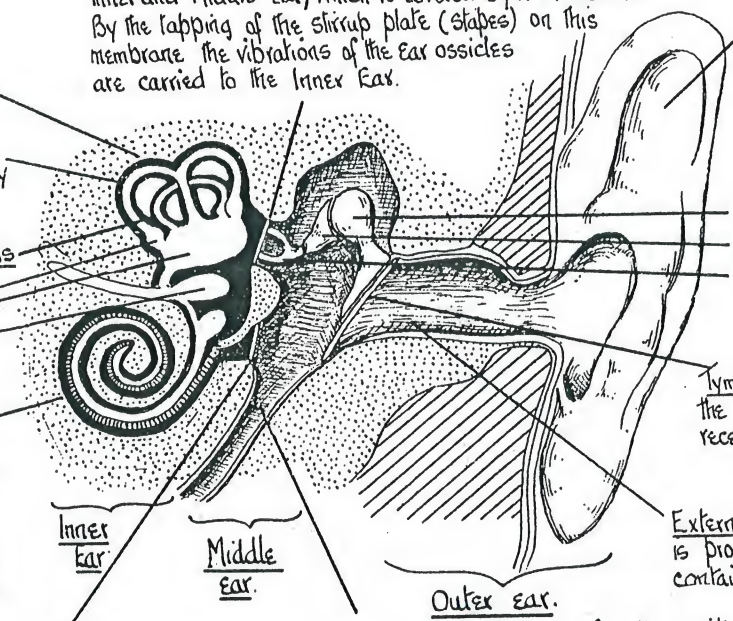
Longitudinal median section from dorsal to ventral surface.



M.W.M.J.

MAMMALS - SENSE ORGANS. THE HUMAN EAR. PARTS AND FUNCTIONS.

DIAGRAM OF THE HUMAN EAR.



Fenestra ovalis (oval window). -(Opening between the inner and Middle ear) which is covered by a membrane. By the tapping of the stirrup plate (Stapes) on this membrane the vibrations of the ear ossicles are carried to the Inner Ear.

Bony Labyrinth (cavity in part of the Temporal bone.)

Perilymph - a lymphatic fluid which lies between the bony and membranous labyrinth

Membranous Labyrinth containing the lymphatic fluid Endolymph. — Semi-circular canals with ampullae; Utriculus; Sacculus

Cochlea. Part of the inner ear, characteristic of Mammals. The perception of sound quality and tone is attributed to the elaborate sense organ (Organ of Corti) developed in the Cochlea.

External Ear (Pinna or concha) which in man, with few exceptions has lost its power of movement. It consists of elastic cartilage. In many mammals the pinna is used as an ear trumpet to gather up the sound waves.

Malleus or hammer bone; Incus or anvil bone; Stapes or stirrup bone. — Ear Ossicles which transmit the vibrations from the drum to the Fenestra Ovalis

Tympanic membrane or ear drum separates the Middle ear from the Outer ear. On the reception of sound waves, the membraneous drum is thrown into vibrations.

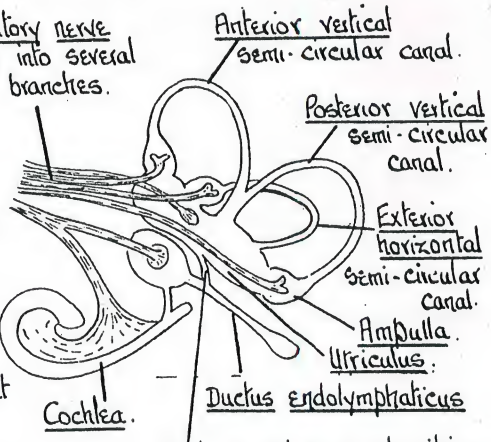
External Auditory Meatus - the entrance of which is provided with hairs, and whose walls contain small glands which secrete wax.

Inner Ear. Middle ear. Outer ear.

Eustachian tube, leading from the cavity of the middle ear to the pharynx. It serves to equalise the atmospheric pressure on both sides of the drum. The Eustachian tube is homologous with the spiracle of Dogfish.

Fenestra rotunda (round window) The vibrations set up in the perilymph of the bony labyrinth, and in the Cochlea, by the vibrations of the oval window, pass up the Cochlea and down again to the round window. As a result, the round window is pushed outwards as the oval window is pushed inwards

Diagram of the Membranous Labyrinth and Cochlea, to show the endings of the Auditory Nerve. (After Huxley)



Auditory nerve dividing into several branches.

Anterior vertical semi-circular canal.

Posterior vertical semi-circular canal.

Exterior horizontal semi-circular canal.

Ampulla.

Utriculus.

Cochlea.

Ductus endolymphaticus

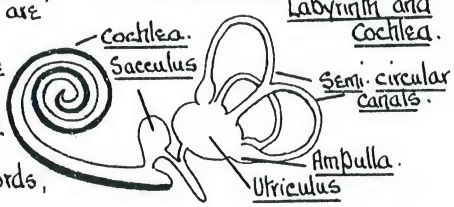
Ductus reuniens (canal uniting the cavity of the Sacculus with that of the Utriculus.)

There is one spot of sense cells provided with hairs developed in each ampulla, in the Sacculus, and in the Utriculus. There is a branch of the Auditory nerve to each spot, so that the slightest movement of the endolymph, within the labyrinth against these hairs excites the nerve fibrils.

Cochlea

The waves set up in the perilymph of the Cochlea beat against the membranous canal, and so set the endolymph into motion. This stimulates the sensory hair cells. Certain of the latter are rod-shaped and are known collectively as the organ of Corti. They are regarded as responsible for the special sense of hearing. In other words, they are constructed so as to analyse sounds.

Diagram of Membranous Labyrinth and Cochlea.



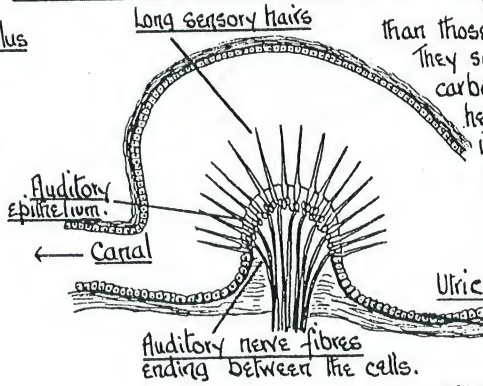
Cochlea. Sacculus. Semi-circular canals. Ampulla. Utriculus.

The semi-circular canals, Sacculus and Utriculus are the organs of orientation. The movement of the endolymph upon the sense cells in the ampullae, the sacculus and the utriculus, stimulates them, and on transmission to the brain the organism appreciates its direction, and rate of movement in space.

The Mammalian Ear serves

1. to perceive sound quality and tone and
2. to acquaint the mind of the varying positions of the head.

Diagram of Longitudinal Section of Ampulla. The sensory or auditory hairs here are much longer than those in the rest of the labyrinth. They support tiny lumps of Calcium carbonate which roll when the head is moved, and coming into contact with other hairs stimulate other fibres, with the result that what appeared vertical before, no longer does so.



Long sensory hairs

Auditory epithelium.

← Canal

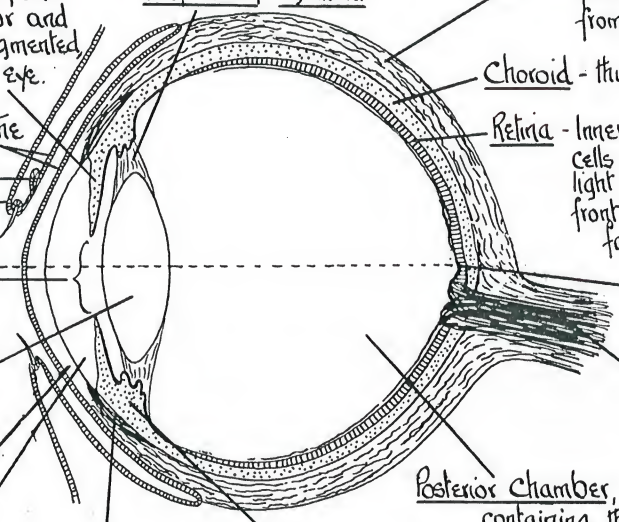
Utriculus →

Auditory nerve fibres ending between the cells.

Ordinary epithelium lining the greater part of the ampulla.

M.W.M.J.

Diagram of the Longitudinal Section of the Human Eye.



Iris - Continuation of the choroid in front, and forming a partition between the anterior and posterior chambers of the eye. It is pigmented and so responsible for the colour of the eye.

Conjunctiva - lining the lids and covering the Cornea.

Gland.

Upper lid, with **eyelash**

Pupil (the aperture surrounded by the Iris) can be increased or decreased by the activity of the Iris muscles, and so controls the amount of light which enters the eyeball.

Lens (which focusses the image on the Retina) is a transparent biconvex elastic structure which is held in position by the suspensory ligament.

Cornea. Thick transparent tissue which is a continuation of the sclerotic in front of the eye.

Anterior chamber containing the **watery aqueous humour**.

Suspensory ligament.

Sclerotic - Thick fibrous connective tissue forming the "white" of the eye as seen from the front.

Choroid - thin layer, pigmented and rich in blood vessels.

Retina - Innermost sensory layer, consisting of cells specialised for the perception of light waves. It thins off towards the front of the eye. Over its innermost surface spread the fibres of the Optic nerve.

Fovea centralis (yellow spot) - the most sensitive patch on the Retina

Optic nerve, which penetrates the Sclerotic, choroid and Retina, at a point known as the "Blind spot"

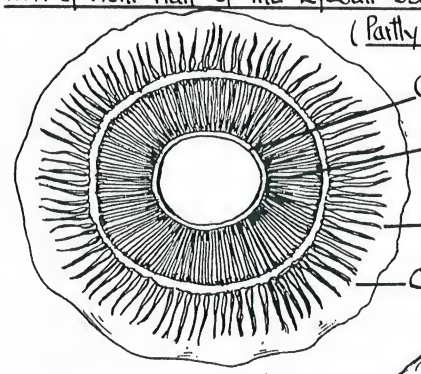
Posterior chamber, containing the **gelatinous Vitreous humour.**

Ciliary Processes - thickening of the choroid coat at the point where the suspensory ligament is attached

Ciliary Muscle. which pulls on the lens and by varying its tension makes the lens thinner or thicker from back to front. This alters its focal length and results in its power of accommodation.

View of Front Half of the Eyeball seen from behind. (Lens removed)

(Partly after Huxley.)



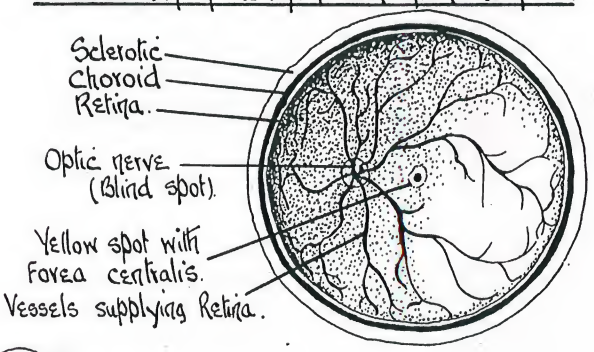
Circular fibres

Radiating fibres of the Iris

Ciliary processes.

Choroid

Posterior Half of the Eye, seen from the front.



Sclerotic

Choroid

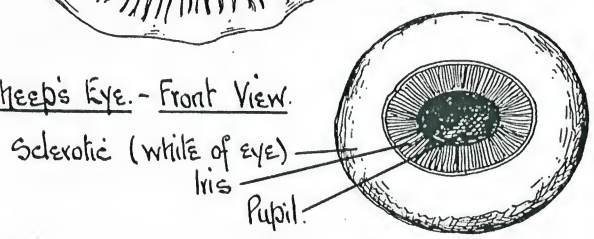
Retina.

Optic nerve (Blind spot).

Yellow spot with Fovea centralis.

Vessels supplying Retina.

Sheep's Eye. - Front View.

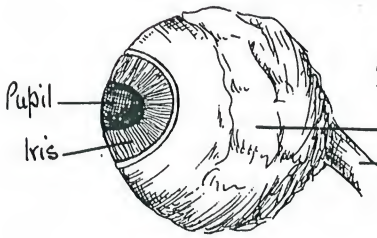


Sclerotic (white of eye)

Iris

Pupil.

Sheeps Eye - Side view.



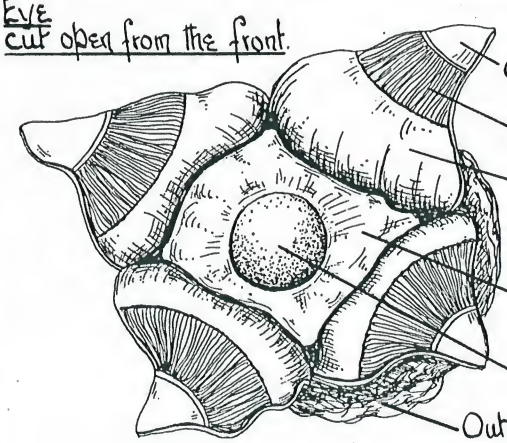
Pupil

Iris

Sclerotic

Optic nerve.

Eye cut open from the front.



Cornea

Iris

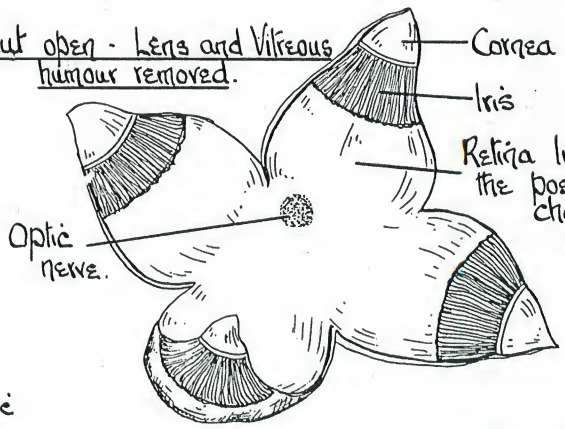
Retinal lining of the Posterior chamber.

Gelatinous Vitreous humour.

Crystalline lens.

Outer surface of the Sclerotic

Eye cut open - Lens and Vitreous humour removed.



Cornea

Iris

Retina lining the posterior chamber.

Optic nerve.

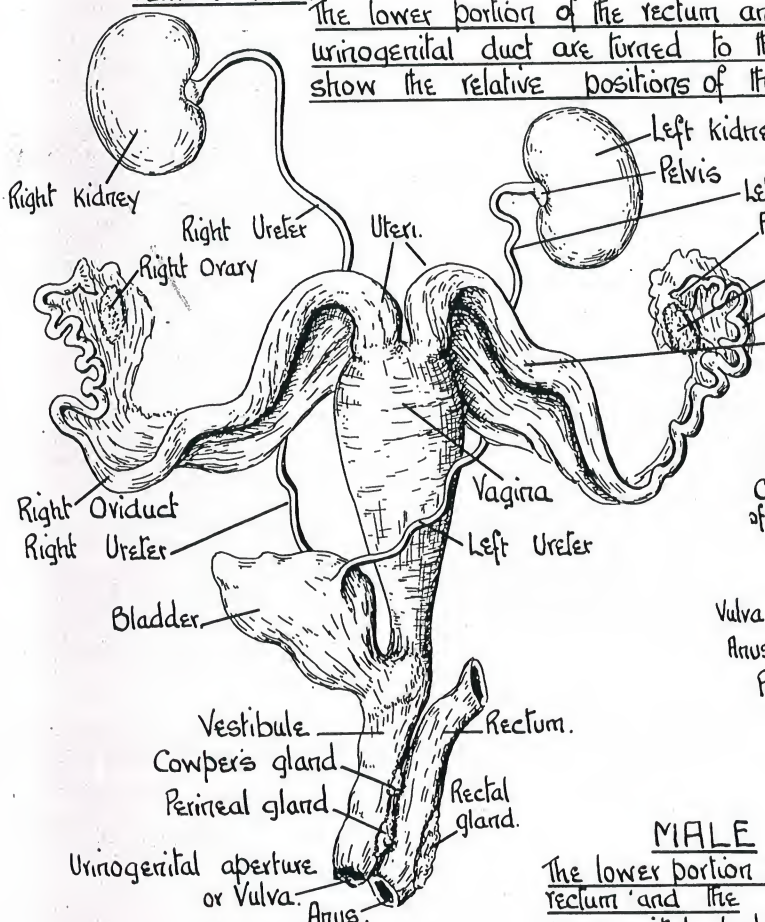
M.W.M.T.

40 LEPUS CUNICULUS - URINOGENITAL ORGANS.

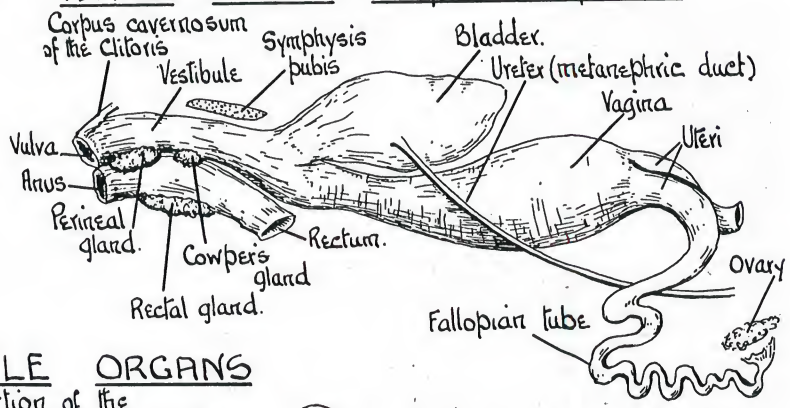
FEMALE ORGANS

Ventral view.

The lower portion of the rectum and urinogenital duct are turned to the right to show the relative positions of the parts.



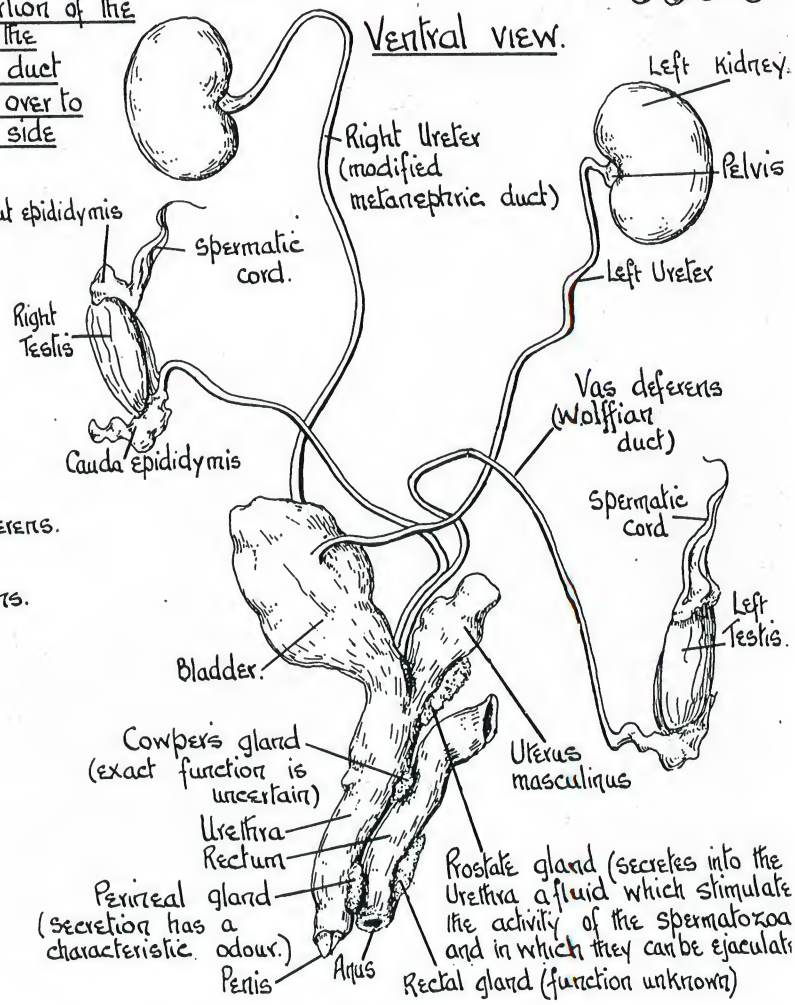
FEMALE ORGANS - View from the left side.



MALE ORGANS

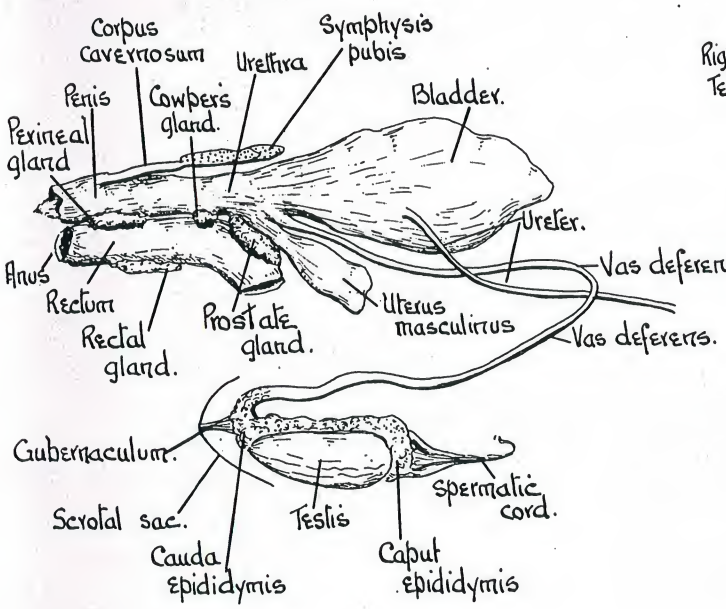
The lower portion of the rectum and the urinogenital duct are turned over to the right side

Ventral view.



MALE ORGANS.

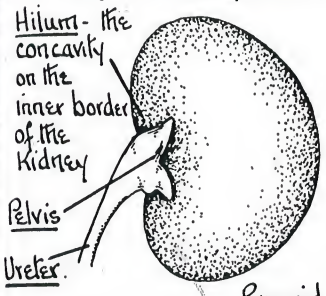
View from the left side.



M.W.M.J.

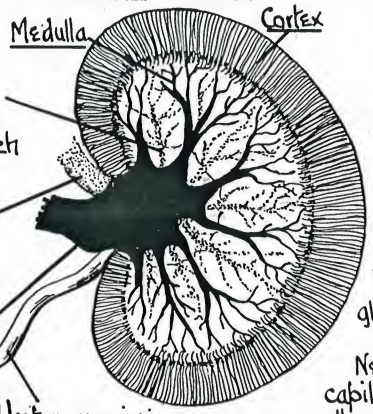
MAMMALS. PROCESSES OF EXCRETION AND REPRODUCTION.

Kidney - (External features).



Renal secretion contains chiefly water. Other substances present are:- Organic compounds such as Urea, Uric acid, Inorganic salts of Sodium, Potassium, Magnesium and Calcium, a little colouring matter and dissolved gases.

Sheep's Kidney
Longitudinal section



Pyramid Each pyramid receives a multitude of openings which are the final terminations of the tubules.

Renal artery enters the Kidney, divides, its branches proceeding outwards between the pyramids

Renal Vein.

Ureter receiving the contents of the Uriniferous Tubules.

Uriniferous tubule (Diagram from Hentschel & Cook)

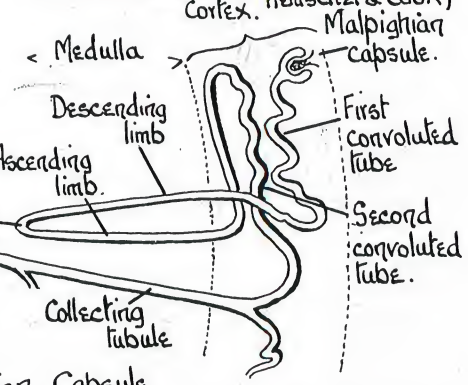
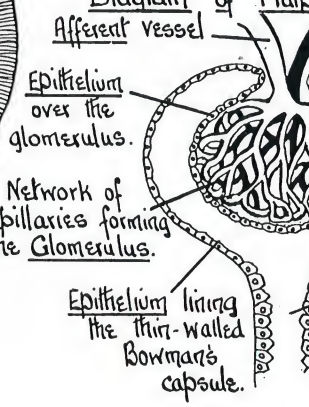
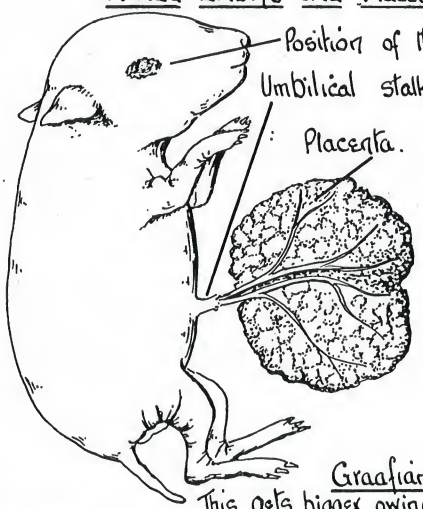


Diagram of Malpighian Capsule.

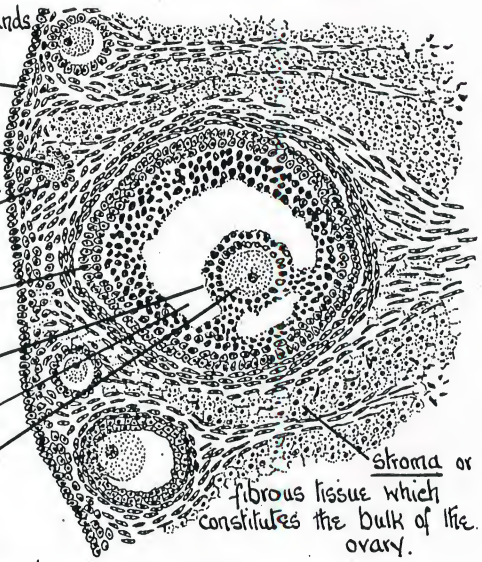


Cells lining the tubule reabsorb nutritive substances from the blood, and add to the contents of tubule such waste matter as Urea, Uric acid, Ammonia etc. The contents of the tubule then pass to the exterior as Urine.

Rabbit Embryo and Placenta.



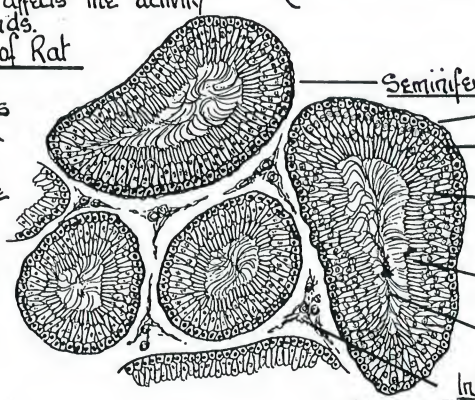
Transverse section of the Ovary of Rabbit.



Graafian follicle.

This gets bigger owing to the increase in the volume of the fluid within the vesicle, and finally projects from the surface and bursts - so liberating the Ovum. The corpus luteum which develops in the follicle after the liberation of the ovum, gradually disappears, unless the animal becomes pregnant, in which case the Corpora lutea produce a hormone which affects the activity of the Uterus and Mammary glands.

Transverse section of the Testis of Rat



Typical vertebrate testis consists of numerous convoluted seminiferous tubules, which are held together and bound by connective tissue.

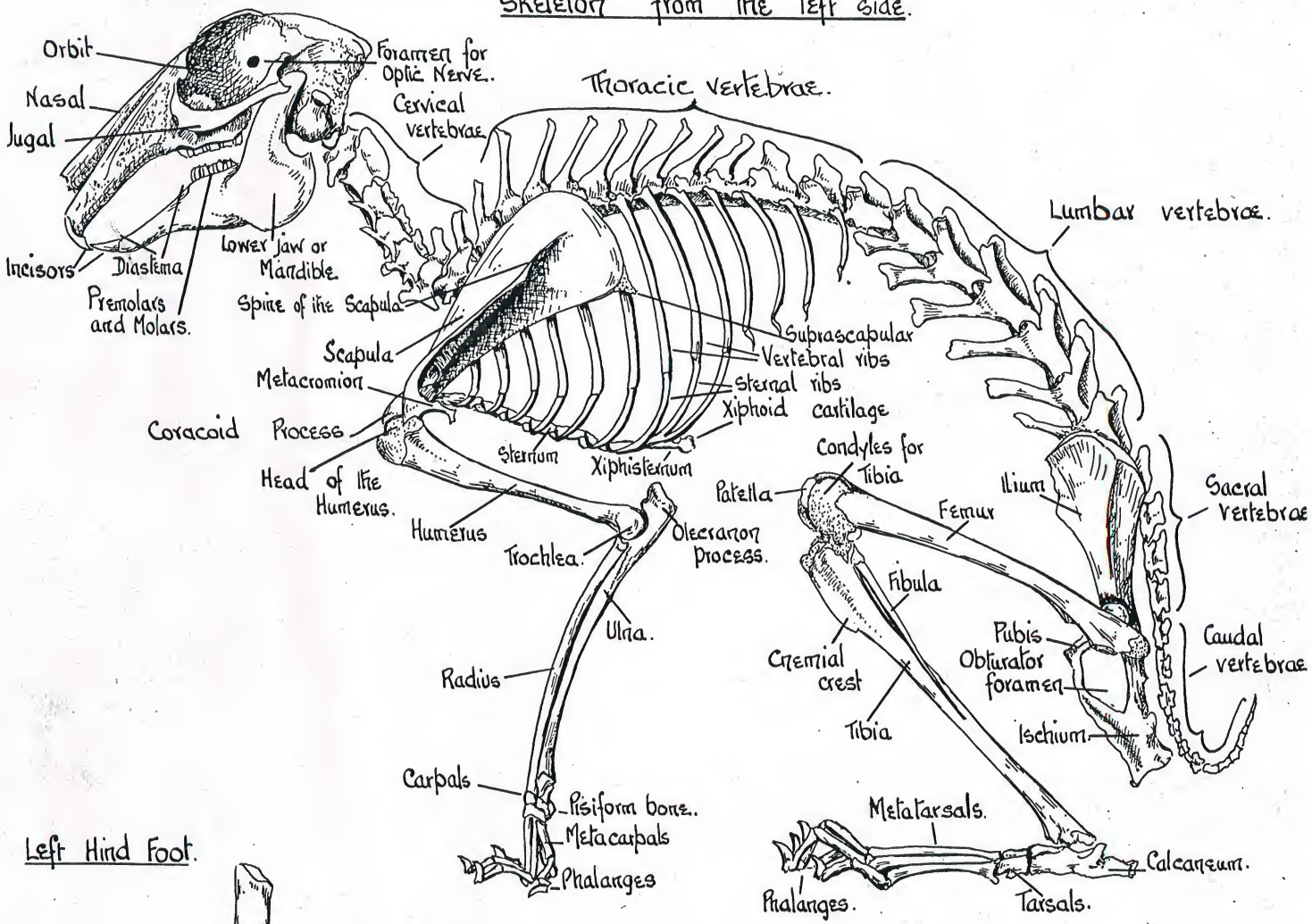
Each tubule is lined by coelomic epithelium which has become modified for the production of spermatozoa.

Interstitial cells — concerned with hormone secretion, the latter promoting the development of secondary sexual characters.

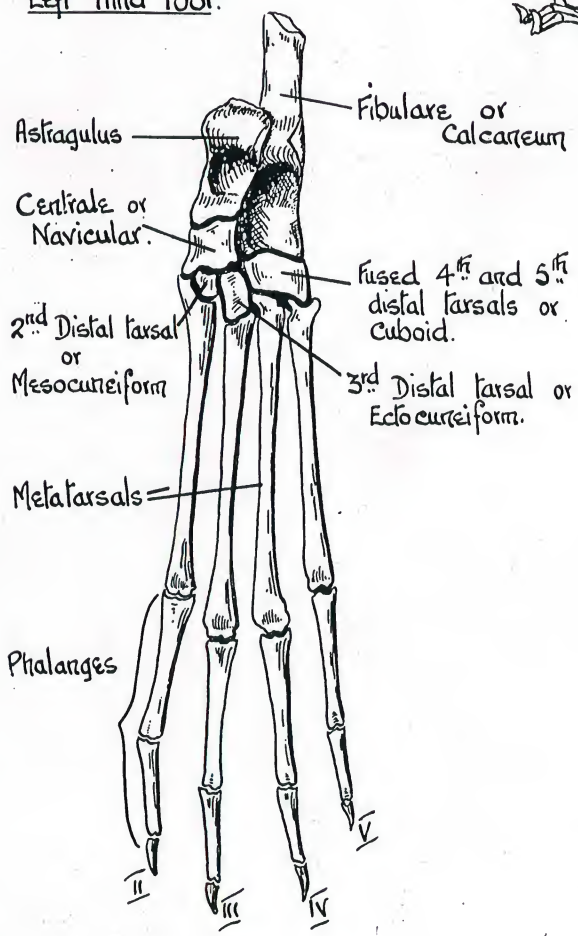
M. W. M. J.

42 LEPUS CUNICULUS (RABBIT) - SKELETON

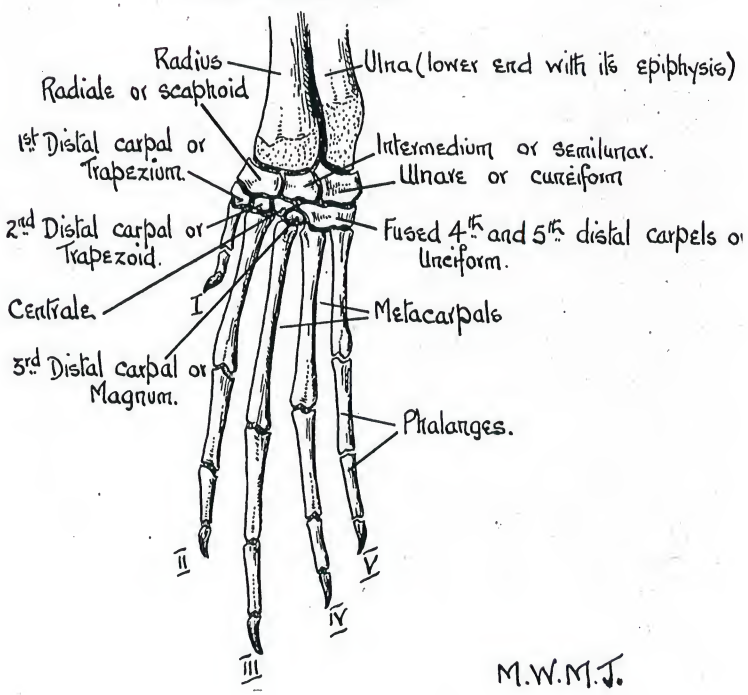
Skeleton from the left side.



Left Hind Foot.



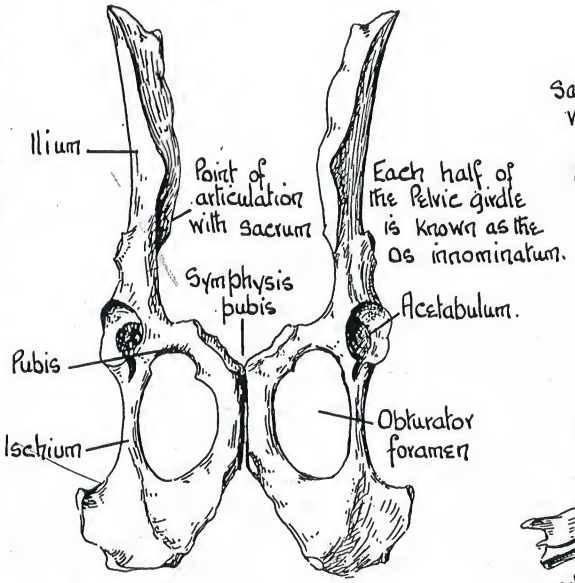
Left Fore Foot



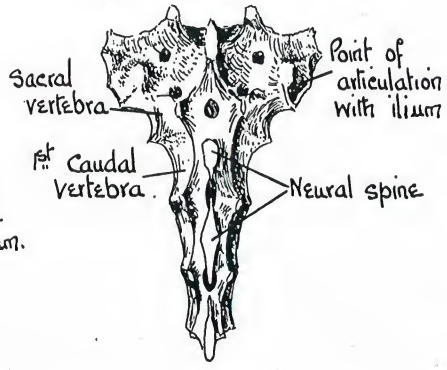
M.W.M.J.

LEPUS CUNICULUS - SKELETON (VARIOUS PARTS)

PELVIC GIRDLE (from above)

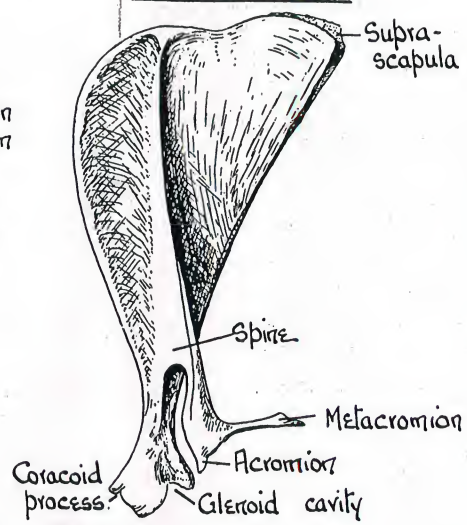


SACRUM (Dorsal view)

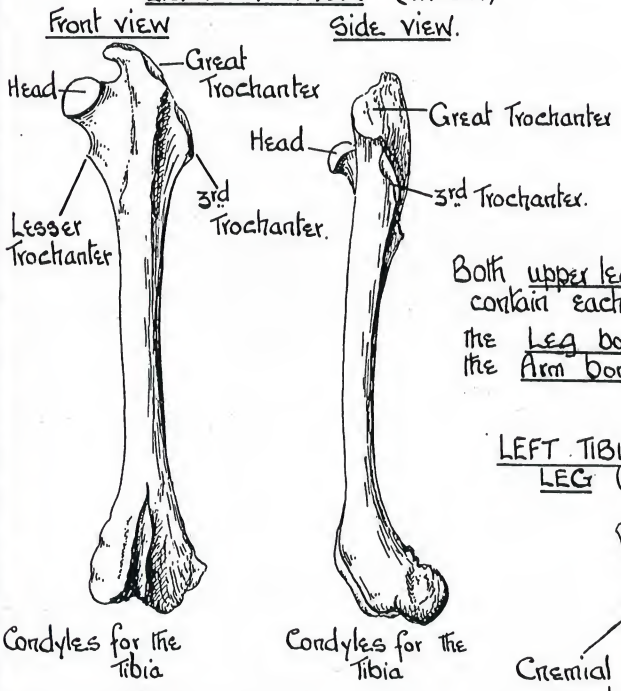


SACRUM (from the right side)

LEFT SCAPULA



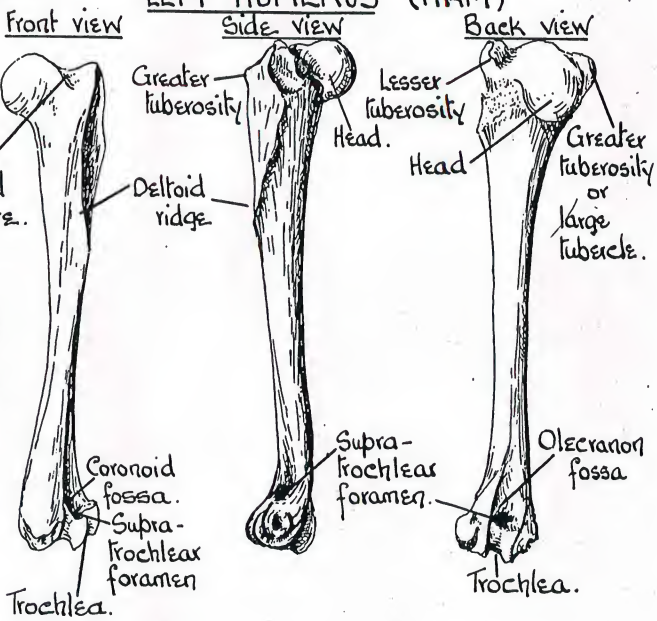
LEFT FEMUR (THIGH)



The upper leg bone or Femur is an elongated bone with a cylindrical shaft and two large extremities. The prominent head articulates with the acetabulum of the Os innominatum, while the distal end bears two large condyles which articulate with the Tibia.

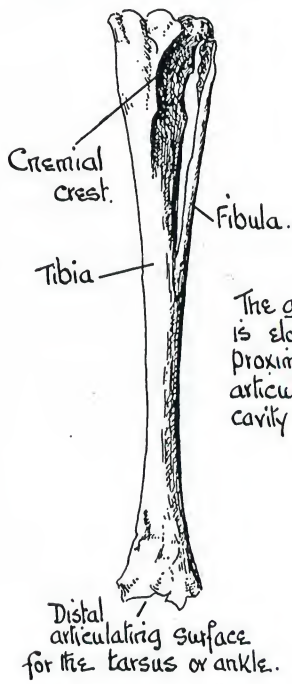
The lower leg contains two bones of unequal size - the larger Tibia and the smaller Fibula. In the adult, the distal portion of the Fibula is completely fused with the Tibia.

LEFT HUMERUS (ARM)



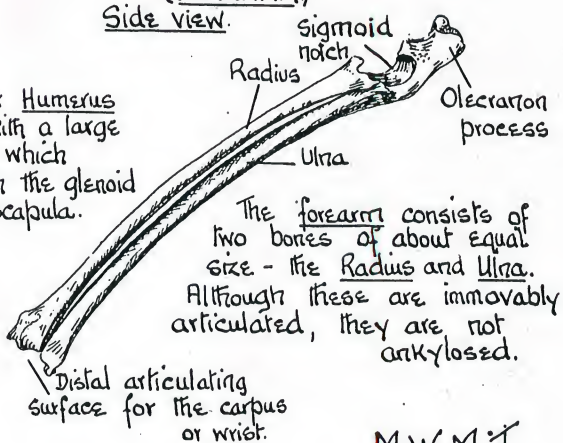
Both upper leg and upper arm contain each a single bone.
The Leg bone or Femur and the Arm bone or Humerus.

LEFT TIBIA and FIBULA
LEG (Front view)



The arm bone or Humerus is elongated with a large proximal head which articulates with the glenoid cavity of the Scapula.

LEFT RADIUS and ULNA
(FOREARM)

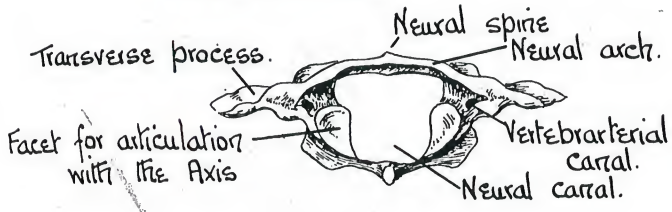


The forearm consists of two bones of about equal size - the Radius and Ulna. Although these are immovably articulated, they are not ankylosed.

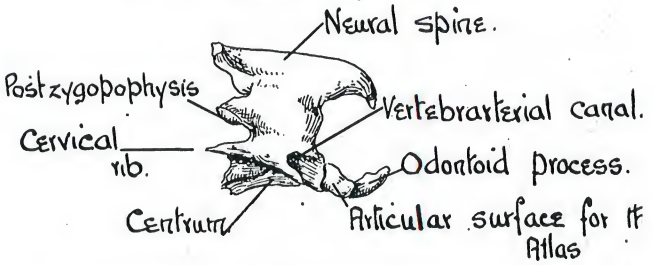
M.W.M.J.

44 LEPUS CUNICULUS — SELECTED VERTEBRÆ.

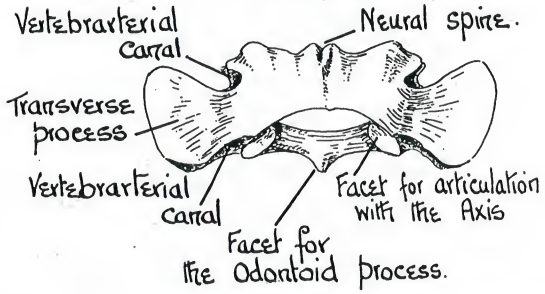
FIRST CERVICAL VERTEBRA or ATLAS. (Posterior View.)



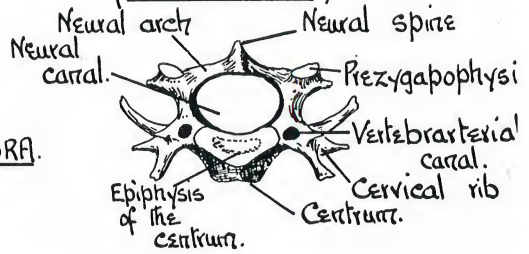
SECOND CERVICAL VERTEBRA or AXIS (from the right side.)



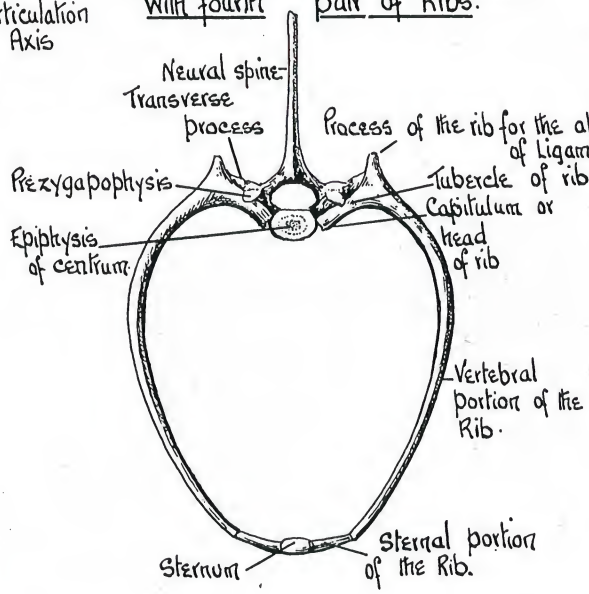
FIRST CERVICAL VERTEBRA or ATLAS (From above.)



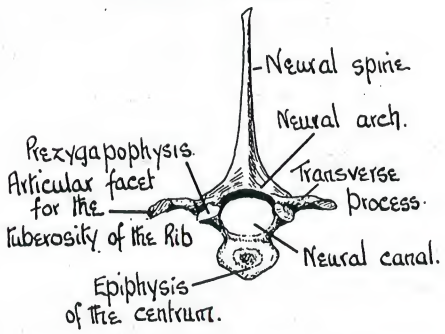
FIFTH CERVICAL VERTEBRA (Anterior view.)



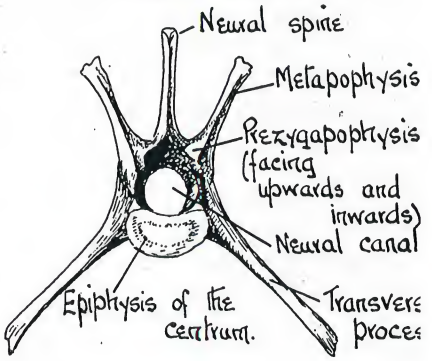
FOURTH THORACIC VERTEBRA. With fourth pair of Ribs.



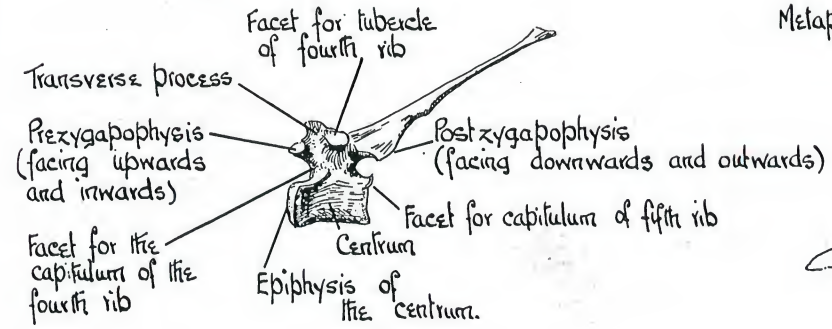
FOURTH THORACIC VERTEBRA (Anterior View.)



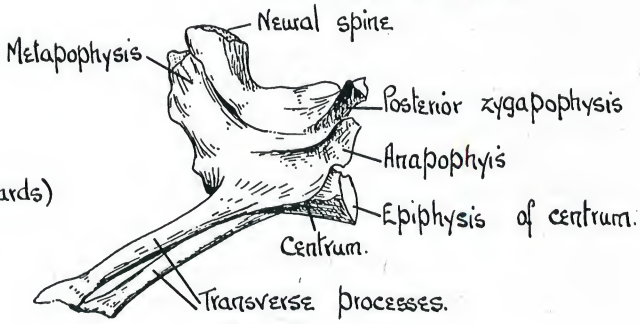
THIRD LUMBAR VERTEBR (Anterior View.)



FOURTH THORACIC VERTEBRA. (From the left side)



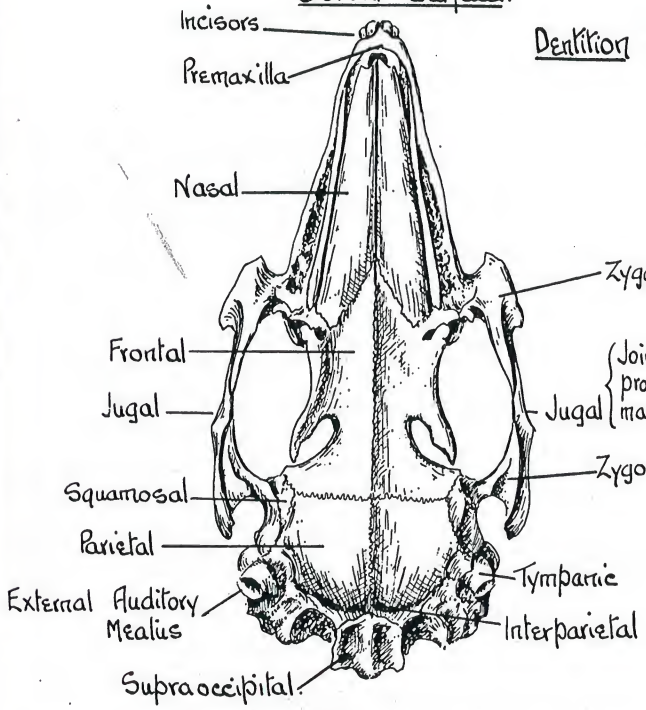
THIRD LUMBAR VERTEBRA. (From the left side)



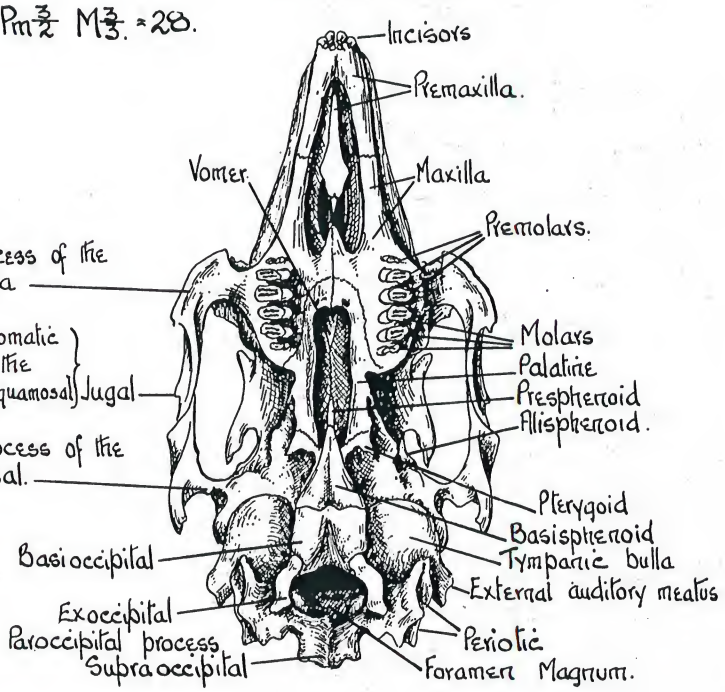
M.W.M.J.

Dorsal Surface.

Dentition $I\frac{2}{1}\ C\frac{0}{0}\ Pm\frac{3}{2}\ M\frac{3}{3} = 28$.

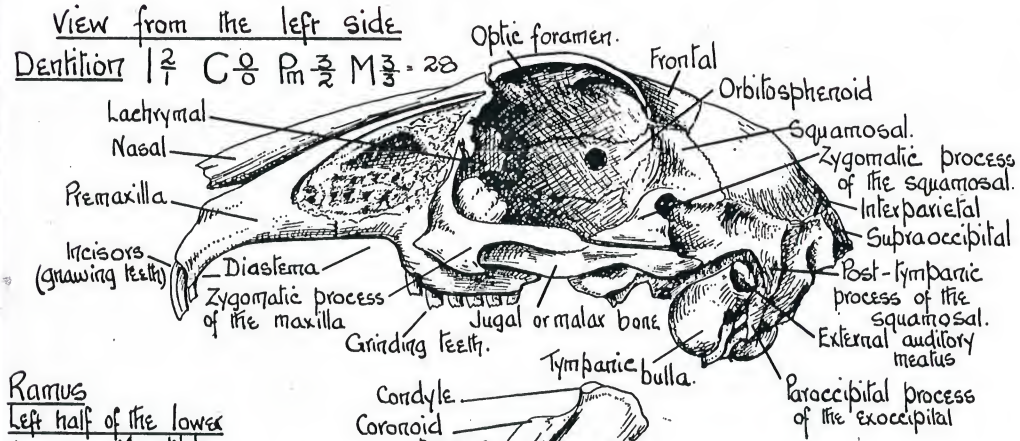


Ventral Surface.



View from the left side

Dentition $I\frac{2}{1}\ C\frac{0}{0}\ Pm\frac{3}{2}\ M\frac{3}{3} = 28$



Ramus
Left half of the lower jaw or Mandible

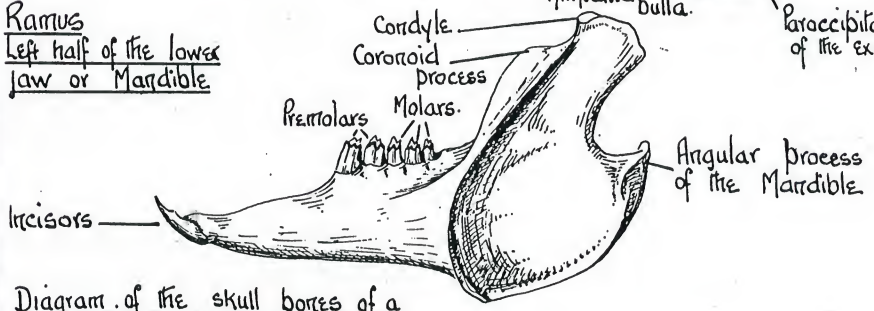
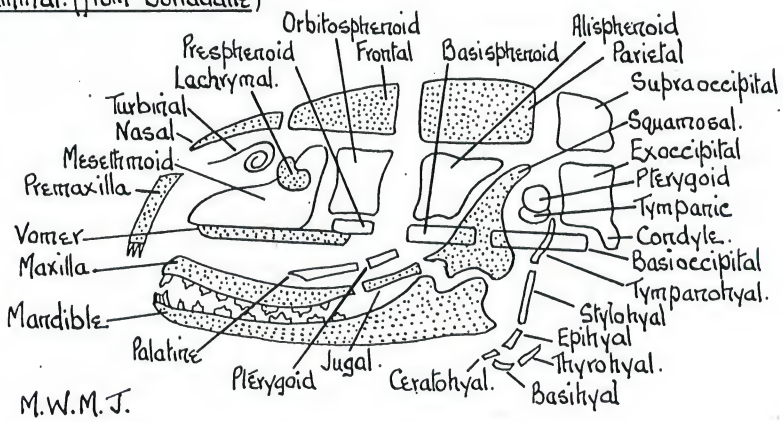


Diagram of the skull bones of a Mammal. (from Borradaile)



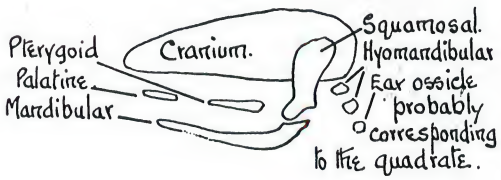
M.W.M.J.

Diagram of the Jaws of Vertebrate Animals (from Borradaile)

Hyostylic arrangement in Dogfish, where the hyomandibular takes part in the suspension of the lower jaw.

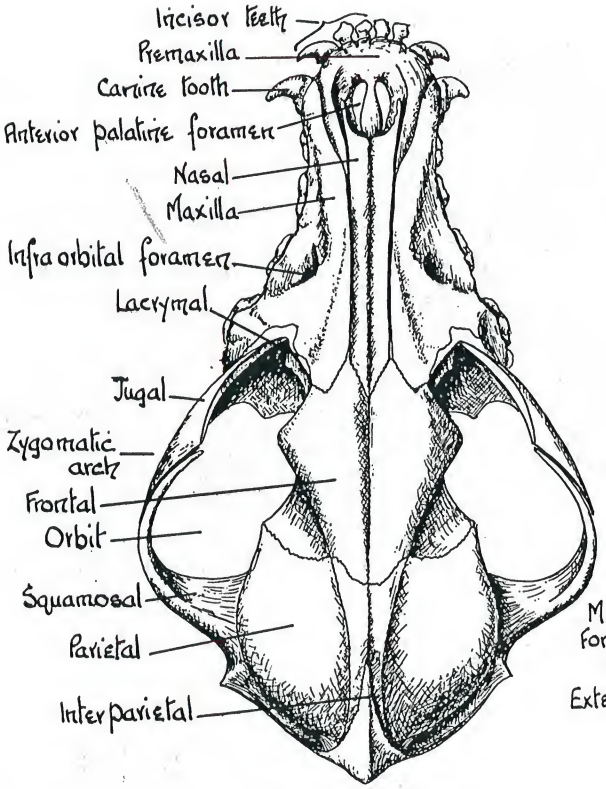
Autostylic arrangement in Frog
Here the jaw is suspended by the quadrate (similar arrangement in Reptiles and Birds).

Arrangement in Rabbit where the lower jaw is suspended by the Squamosal.

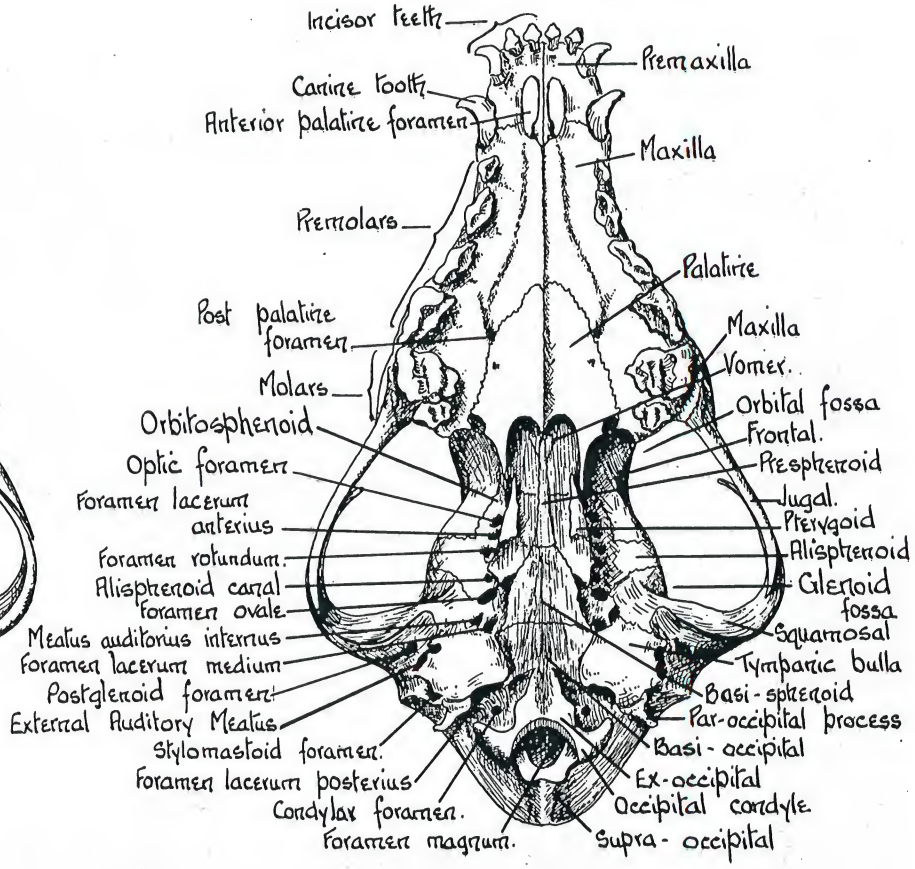


CANIS FAMILIARIS (DOG) SKULL AND DENTITION.

Dorsal Surface



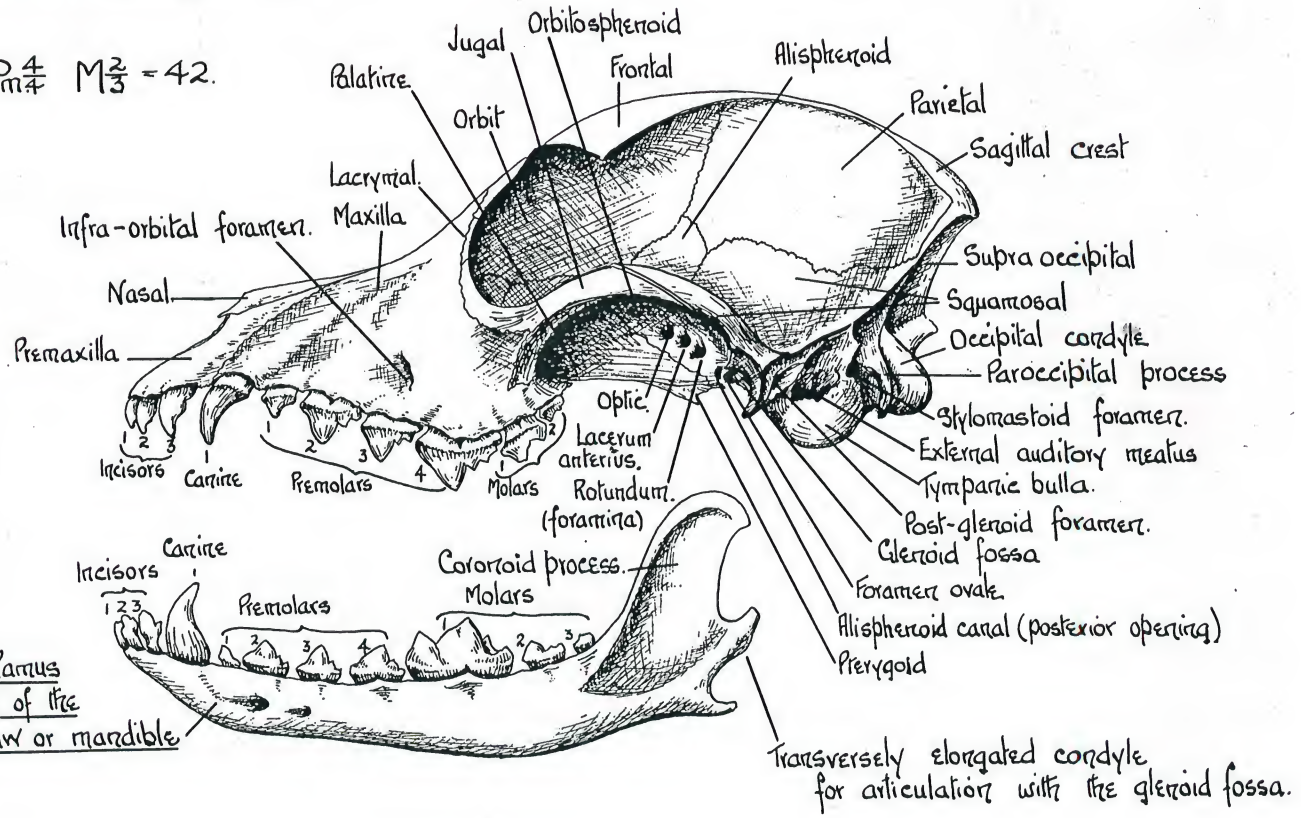
Ventral Surface.



View from the left side

Dentition.

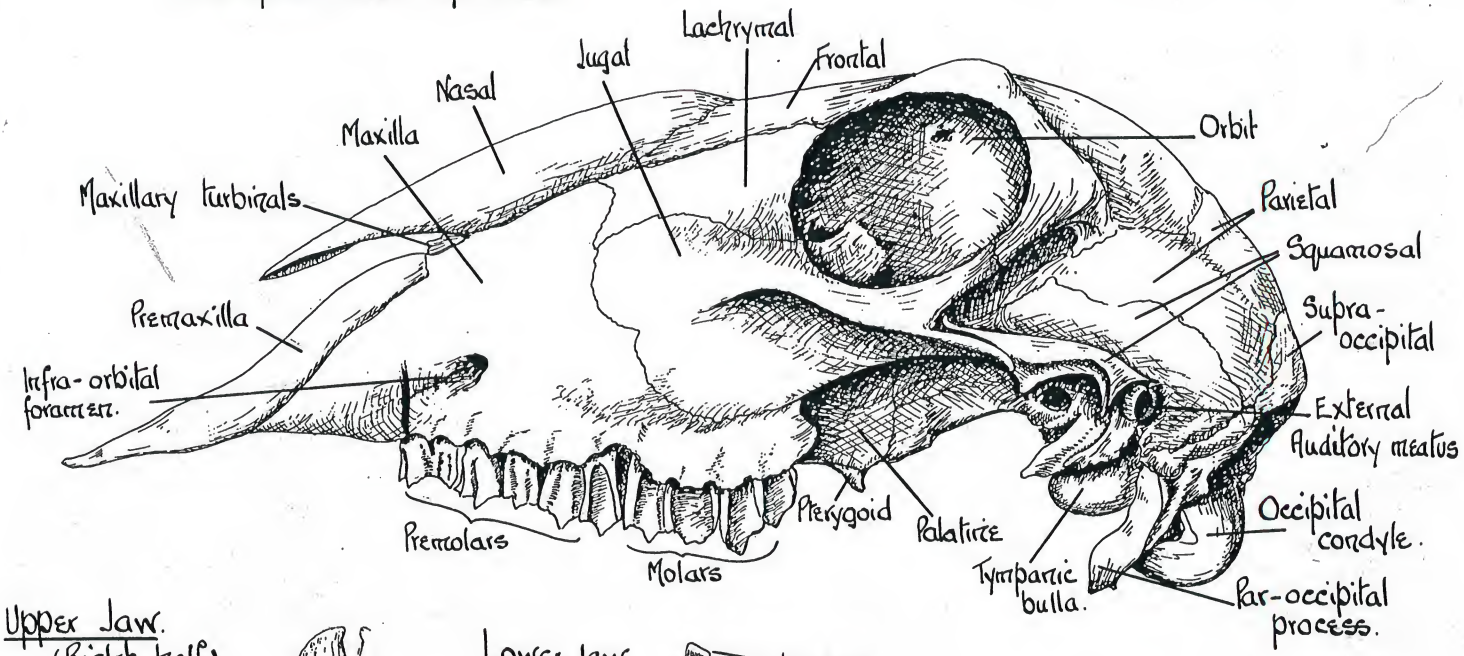
$I\frac{3}{3}\ C\frac{1}{1}\ Pm\frac{4}{4}\ M\frac{2}{3} = 42.$



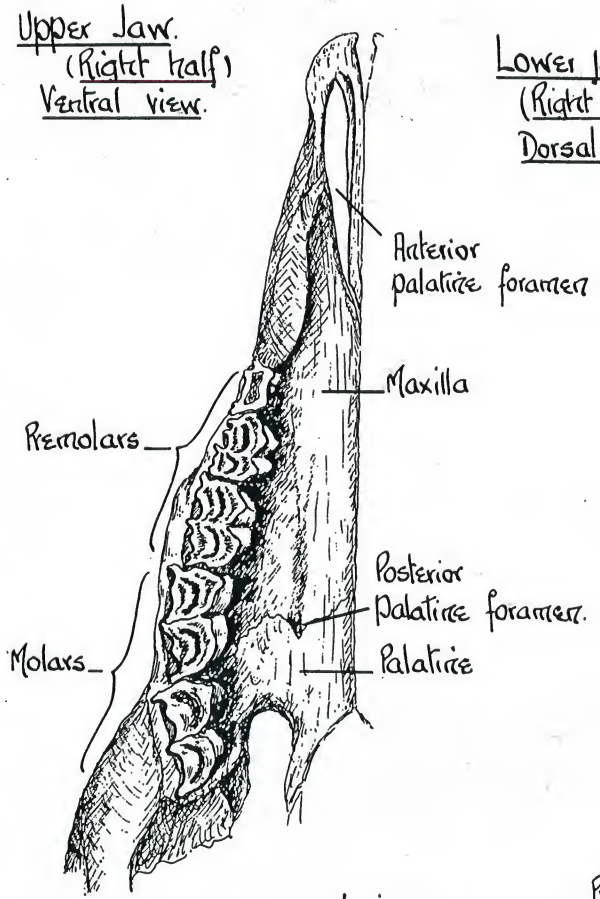
M.W.M.J.

OVIS ARIES (SHEEP). SKULL AND DENTITION

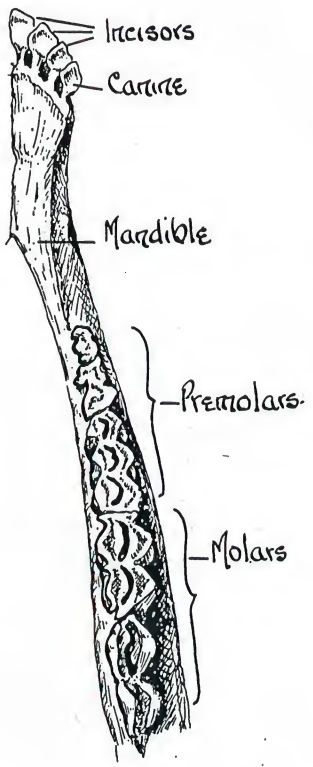
View from the left side.



Upper Jaw. (Right half) Ventral view.

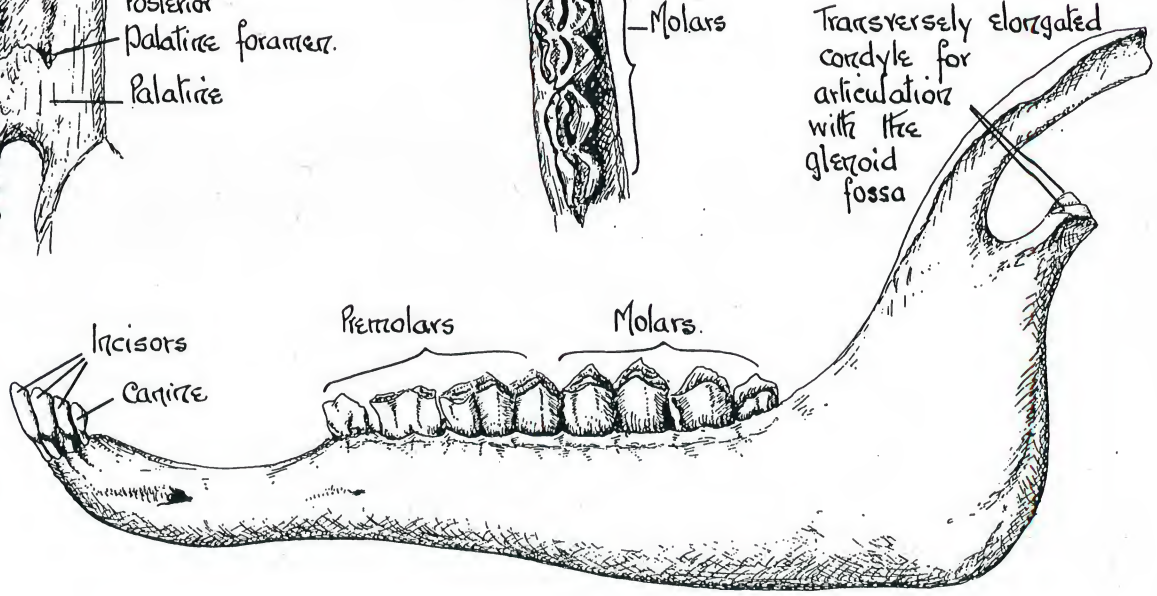


Lower jaw (Right half) Dorsal view.



Dentition

$$I\frac{0}{3}\ C\frac{0}{1}\ Pm\frac{3}{3}\ M\frac{3}{3}$$

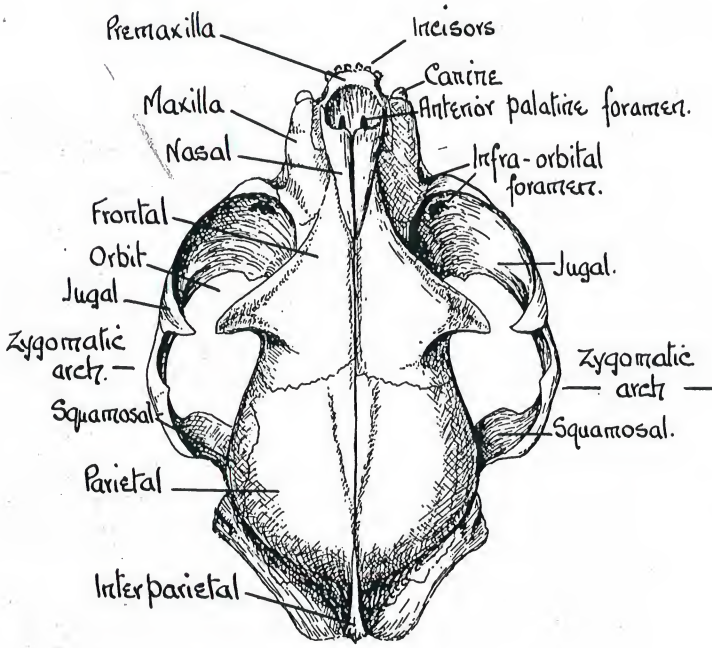


Ramus (Left half of the lower jaw or Mandible)

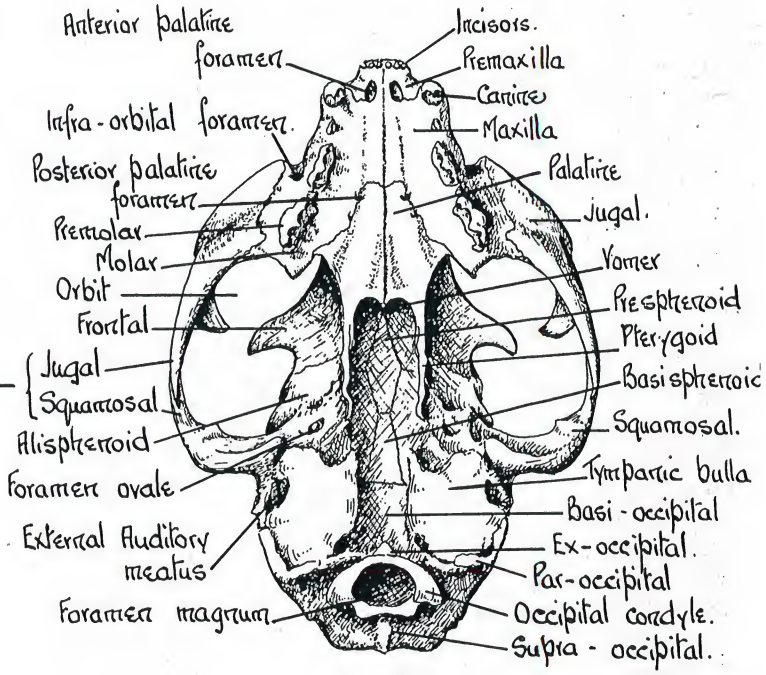
M.W. M.J.

48. # FELIS (CAT). SKULL AND DENTITION

Dorsal surface.



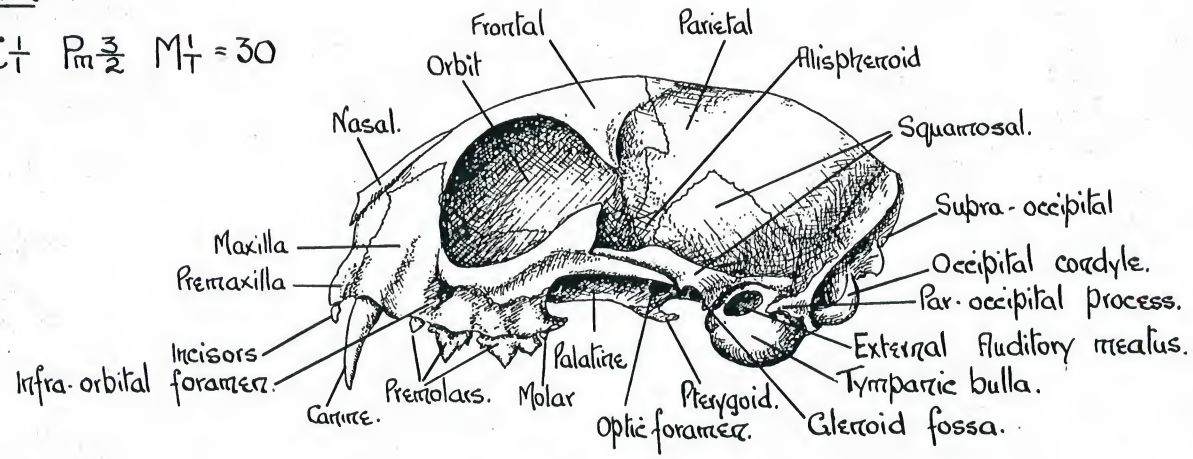
Ventral surface.

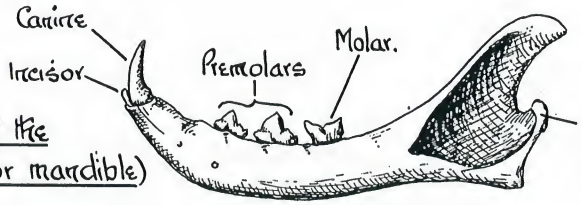


View from the left side.

Dentition.

$I\frac{3}{3}\ C\frac{1}{1}\ Pm\frac{3}{2}\ M\frac{1}{1} = 30$





Ramus. (Left half of the lower jaw or mandible)

Transversely elongated condyle for articulation with the glenoid fossa.

M.W.M.J.

STAGES IN THE LIFE HISTORY OF THE HOUSE-FLY. (Musca domestica.)

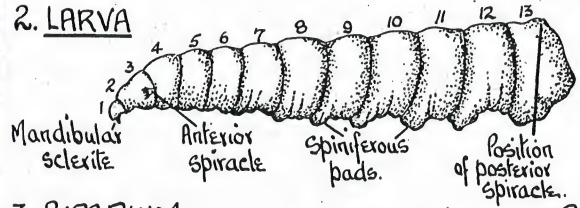
The life history of this insect is of great economic importance, owing to the fact that the fly or imago is responsible for the transmission of various germs, which cause diseases, deadly to mankind.
Female house-fly deposits her eggs in decaying animal and vegetable matter, including stable manure and human faeces. One hundred or more eggs are laid, in five or six batches, during the three or four months of summer.

1. EGG.

I EGG. The white cigar-shaped eggs measure about $\frac{1}{25}$" long, and will hatch in about twelve hours should the temperature be suitable and the substratum moist.

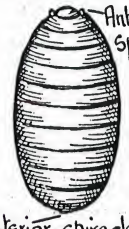
II LARVA or Maggot, which emerges is a white segmented creature about $\frac{1}{20}$" long, without any limbs, and possessing a small "head", which is readily drawn in at the anterior end. Twelve segments are visible – the sixth to twelfth bearing spinous pads which act as locomotory organs. There are no ocelli, but the two oral lobes on either side of the mouth are well supplied with nerves and so probably act as an adequate sensory organ. Black hook-like structures between the oral lobes are used for locomotion and feeding, and represent mandibles.

2. LARVA



The maggot breathes by trachea which open externally by the anterior pair of spiracles on segment two, and the posterior pair on the last segment. It seeks the moist dark places and during this stage in its life-history moults only twice. If conditions are favourable larval life will terminate after about five days, when the larva will seek a dry place in order to pupate.

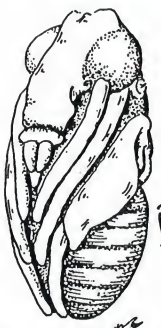
3. PUPARIUM



Puparium after emergence of the adult or Imago

(After C.G. Hewitt.)

Pupa dissected out of Puparium

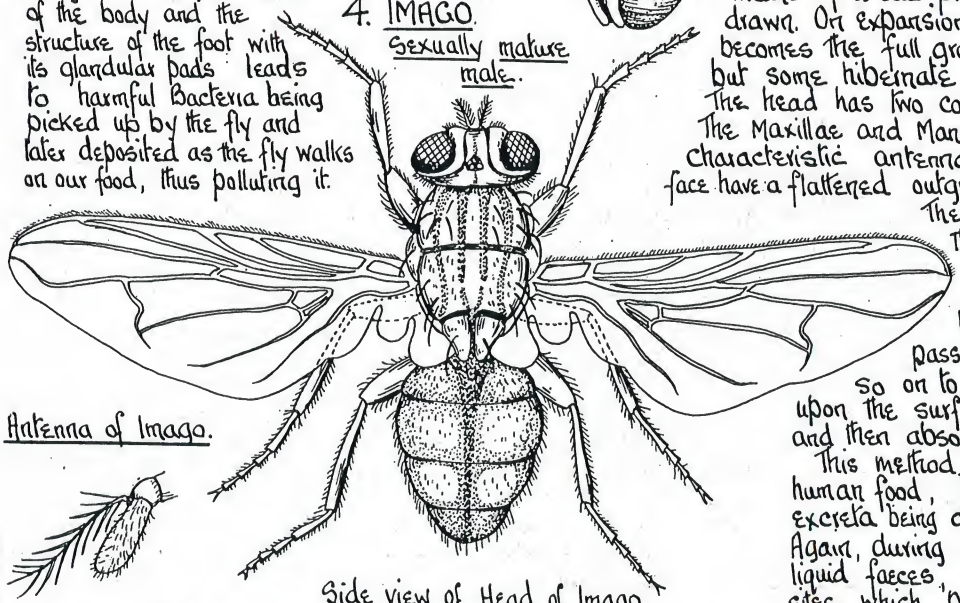


III PUPA. This brown, barrel-shaped structure is formed from the larva which shortens considerably so that the segments appear to be telescoped at the front end. The transformation from larva to pupa takes place without any moult.
During the three or four days of pupal life in the summer, (or through the winter) the internal organs disintegrate and form a jelly-like mass, which gives rise to cells from which new organs are produced.

IV IMAGO. When the adult insect or Imago emerges from the pupal case, it does so by lifting off one end by means of a sac protruding from its head. The sac is then withdrawn. On expansion and hardening of the wings, the insect becomes the full grown Imago. Many flies die in the Autumn, but some hibernate through the winter.
The head has two compound eyes and three simple eyes (ocelli). The Maxillae and Mandibles, as such, are not present, while the characteristic antennae which are sunk into the concavity of the face have a flattened outgrowth from the third segment.
The tubular Proboscis is formed apparently from the Labrum and Labium and is characteristic. It bears in front two small unjointed palps, while at the Proboscis tip are two pads traversed by small canals. The saliva passes down the Proboscis into the canals and so on to the pads. The latter spread the saliva upon the surface of the food which is thus dissolved and then absorbed by the Proboscis.
This method of feeding, sometimes on excreta and then human food, leads to pathogenic Bacteria from the excreta being deposited upon our own food with the saliva. Again, during contact with such food the fly discharges liquid faeces, probably containing the eggs of parasites which pass unharmed through the gut of the fly, but on reaching that of man may cause some virulent disease.
The thorax bears only one pair of wings for flight, and a pair of rudimentary hind wings or Halteres, which, being provided with sensory structures, are probably concerned with the maintenance of balance. Attached to the thorax are three pairs of legs.
Respiration takes place by trachea which open externally by one pair of thoracic spiracles and seven pairs of abdominal spiracles.
Each leg ends in a five-jointed tarsus, the last joint bearing two claws. Under each claw is a pad covered with hairs. When the pad is pressed, the hairs exude a sticky fluid, which enables the fly to run up slippery surfaces with ease.

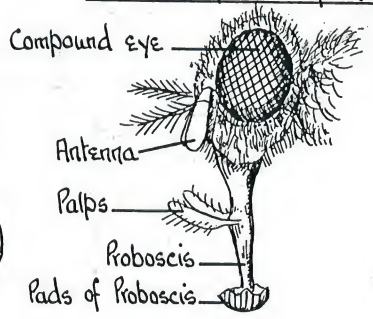
4. IMAGO.
Sexually mature male.

The general hairy character of the body and the structure of the foot with its glandular pads leads to harmful Bacteria being picked up by the fly and later deposited as the fly walks on our food, thus polluting it.

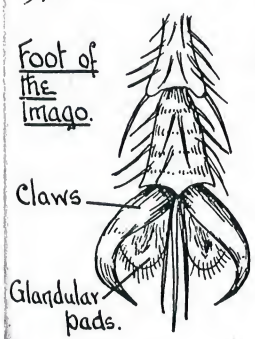


Antenna of Imago.

Side view of Head of Imago



Foot of the Imago.

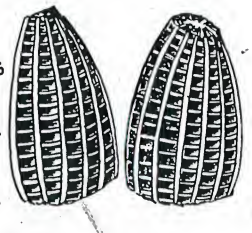


M W.M.J

SO STAGES IN THE LIFE HISTORY OF THE CABBAGE WHITE BUTTERFLY. (Pieris brassicae)

METAMORPHOSIS is the term applied to a series of abrupt changes which take place in the life-cycle of an organism from the free-living larval form to the adult state.

I. EGG



These egg cases form the first food of the Larva.

Fertilisation is internal. The yellow eggs are laid in batches of 60–100 in May and August, those laid in late summer being more plentiful. They are small, blunted, conical structures, which are symmetrically ridged and ribbed. They are found in great numbers on the under surface of Cabbage leaves and Nasturtium leaves.

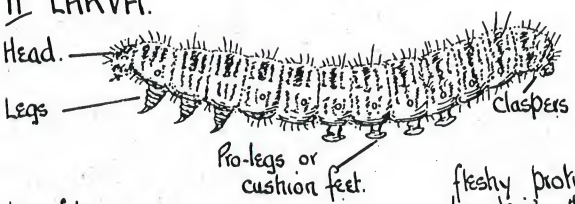
II LARVA.

After hatching the hairy caterpillars keep together for some time, but later separate and feed alone. During the larval period the animal feeds voraciously and outgrows the skin or cuticle, which it periodically sheds, until it eventually reaches its full size.

The body is yellowish green with raised papillae which are black on the back and brown on the sides, and from which stiff hairs project. Behind the head there are thirteen segments.

The first three thoracic segments following the head bear three pairs of 5-jointed legs, each ending in a curved claw.

The remaining segments form the abdomen. Four of the abdominal segments bear paired pro-legs or "cushion-feet", which are unjointed fleshy protuberances, terminating in a cushion with a semi-circular series of hooks, by which the animal clings. The pro-legs on the last segment turn backwards to form the claspers.

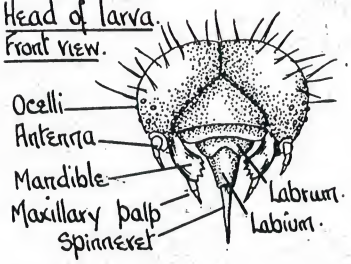



Leg of larva.


Pro-leg of larva.

The compound eyes characteristic of the butterfly are represented in the larva by three pairs of simple eyes, or ocelli. The antennae, maxillae and labial palps of the adult are rudimentary, while the mandibles, which are absent from the adult, are here large and strong, biting organs.

Projecting from the labium, or lower lip, is the spinneret by which the products of the paired silk glands are poured out. The silk is a sticky fluid which hardens on exposure to air. By movement of the head from side to side a silk zig-zag ladder is formed as the animal progresses, and it is on to this that the animal clings by means of its pro-legs. Thus it is able to get a firm "foothold" on the most difficult surface.

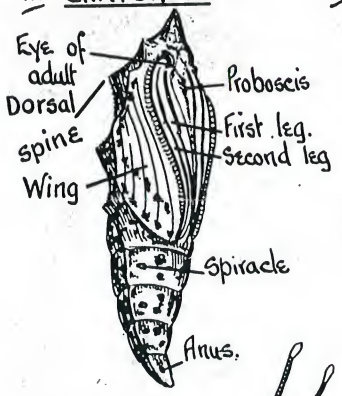


Respiration takes place by means of trachea, which open to the exterior by spiracles on the first thoracic and first eight abdominal segments.

When fully grown the larva ceases to feed and begins to climb, as described above, in search of a suitable place to pupate. On finding this, it spins a small quantity of silk by which to suspend. About 48 hours later the cuticle splits along the back, and is worked off at its posterior end. Meanwhile the body within shortens and swells, taking on the chrysalid or pupal form.

III CHRYSALIS OR PUPA.

Here the characteristic features of the Butterfly are evident. The mandibles have disappeared and the abdomen has shortened. Rudiments of the wings, compound eyes, antennae and proboscis are present. After emergence from the last larval skin, a chitinous fluid exudes from the body and hardens round the pupa as a yellowish-green "shell" decorated with black and yellow spots. The chrysalis now remains quiescent for 2 or 3 weeks if pupated during the summer, or through the winter if pupated in the Autumn.

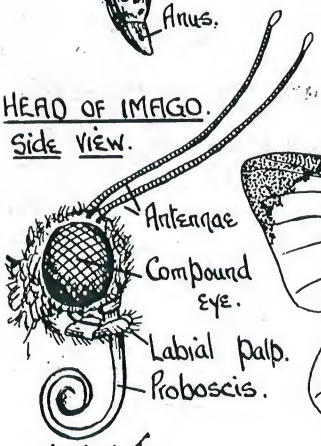


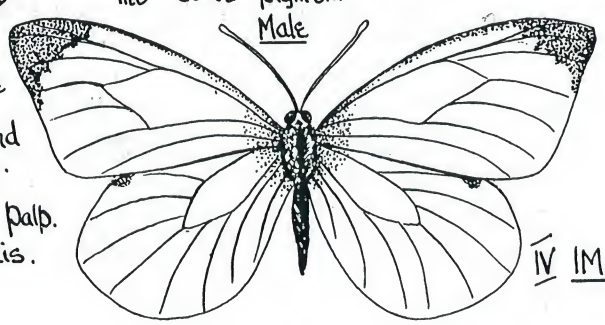
IV IMAGO.

When conditions are favourable, the Imago emerges by the splitting of the pupal skin along the back of the thorax. During the pupal stage there has been a tremendous breakdown and reorganisation of organs, as well as the formation of new ones.

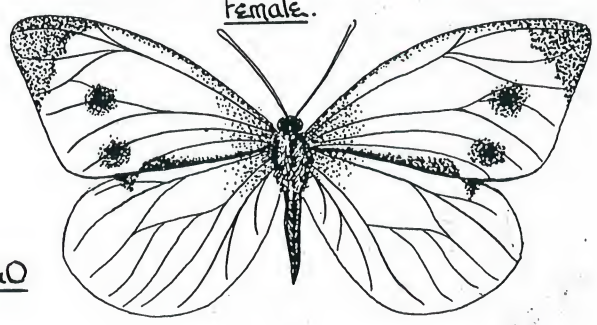
The adult insect shows division into head, thorax, and abdomen.

The thorax which is black and hairy bears three pairs of legs, and two pairs of wings. It is by the difference of decoration in the yellowish white wings that the sexes can be distinguished. The front wings of the female bear two black spots, while the inner margin bears a smudge of the same pigment.





IV IMAGO



M.W.M.J.

BIRDS OF PREY - CARNIVOROUS (Flesh Eaters)

The beak of these birds is particularly adapted to the carnivorous habit. It is short, curved and very sharp, so that the death blow is easily given either by severing the jugular vein or by piercing the skull. In many cases, the feet are also adapted to assist in seizing, carrying, and even dismembering the prey.

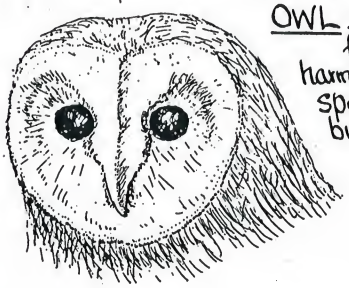
MERLIN

Tremendous liking for young birds, but also devours insects fish and other small animals.

KEA

A member of the Parrot family, the Kea was originally an insect feeder, but on the introduction of sheep into New Zealand it began to frequent the stations, devouring the offal. Later, it began to attack live sheep. It comes in numbers at night, worry the weaker members to death, afterwards devouring the kidney fat.

OWL



Most useful in that it feeds on rats, mice, and other harmful Rodents, as well as sparrows. It is chiefly a nocturnal bird, but not entirely so.

FALCON

Feeds mostly on birds, particularly the larger ones such as Wild Duck etc. Very partial to birds which form the food of man. Strikes and kills its prey with its powerful talons.

RAVEN

As a scavenger, this bird is very useful. On the other hand it is a troublesome pest in that it attacks sea fowl.

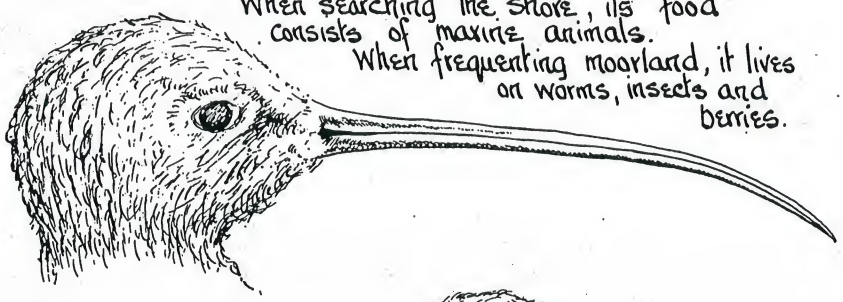
CROW

Very destructive bird, robbing nests and so causing great loss to breeders of game and poultry.

DIET OF WORMS AND OTHER SMALL ANIMAL LIFE.

CURLEW

A bird frequenting the shore. It walks slowly, appearing to bow the head alternately left and right, so that the downward curve of the beak is even with the sand. When searching the shore, its food consists of marine animals. When frequenting moorland, it lives on worms, insects and berries.



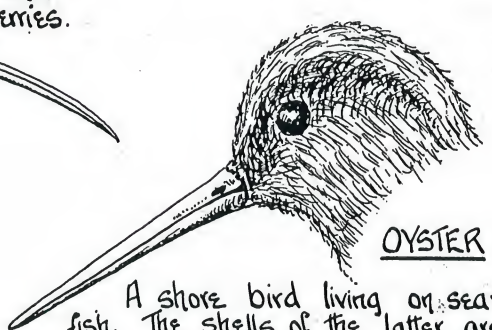
KIWI.

A flightless bird. Unique in that the nostrils are at the tip of the beak. It has extremely poor sight, and feeds chiefly on grubs and berries.

TURNSTONE

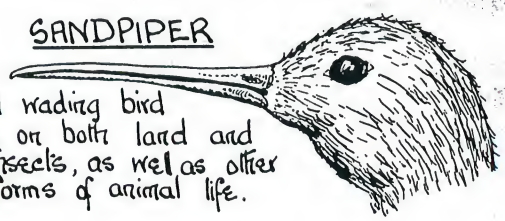
A shore bird with a narrow mouth, but short and strong conical beak, which is upturned at the end and so especially suitable for lifting. Correlated with the short beak is the short neck, so that the driving power behind the beak is the maximum. This bird feeds on small animal life such as shrimps, sand hoppers and shell-fish, which it finds beneath the stones.

OYSTER CATCHER.



A shore bird living on seaworms and shell-fish. The shells of the latter are prized open by a well-adapted bill, which also serves to remove oysters, and related forms, from their firmholds on the rocks.

SANDPIPER



A small wading bird feeding on both land and water insects, as well as other small forms of animal life.

M.W.M.T.

BIRDS · DIET OF SEEDS AND FRUITS

NUTHATCH

This bird is an excellent climber, running both up and down equally well. It is purely a vegetable feeder, and eats in particular, nuts, which it cleverly fixes into a crevice in the bark, splitting them with its strong beak.
The Nuthatch has a preference for Sunflower and Hemp seeds.

NUTCRACKER.

A member of the crow tribe and like them will eat animal food.
It particularly frequents coniferous forests, where it lives upon pine and fir cones.

BUNTING.

The Bunting possesses the short conical beak characteristic of seed-eating birds.
It is very partial to corn.

SISKIN

The adult bird feeds mostly on various kinds of seeds and yet it feeds its young entirely on insects.

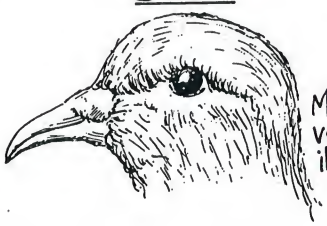
LARK.

Very well adapted to its diet which consists chiefly of seeds swallowed whole.
It feeds also on vegetation
Its great liking for young corn makes it a serious nuisance.
The lark will also devour insects.

CROSSBILL

The crossed bill enables the bird to pick up the smallest seed with ease.
It also prizes open fir cones, a task in which the tongue assists.

DOVE



Mainly a vegetable feeder, its food consisting of seeds and weeds.

BLACKBIRD.

Very fond of succulent fruits.

TOUCAN.

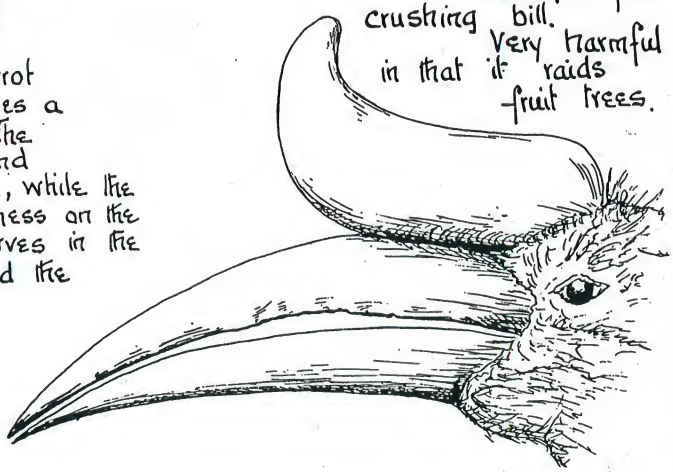
Here the diet consists of succulent fruits Like that of the Hornbill, the bill is especially adapted for the purpose of fruit-crushing

PARROT.

The parrot possesses a relatively short beak. The upper half is curved and movable from the base, while the strong file-like roughness on the inside of the beak serves in the gnawing of nuts and the grinding of seeds.

HORNBILL

Powerful fruit-crushing bill.
Very harmful in that it raids fruit trees.



M.W.M.J.

BIRDS. INSECTIVOROUS (Diet of Insects)

BEE EATER.

This bird sizes bees in its swallow-like flight or awaits its opportunity by the hives.
It's destructiveness to bees is compensated by it's ravages among wasps and other insects.

FLY CATCHER.

Here the bird flies out at the insect, catches it, and immediately returns to its perch.
Insects are also caught on the wing, and even ripped from the ground.

NIGHTJAR

A nocturnal bird feeding entirely on insects found at dusk, or caught on the wing.
It is very partial to bees, and devours wasps, which are readily caught by the wide mouth and small beak.

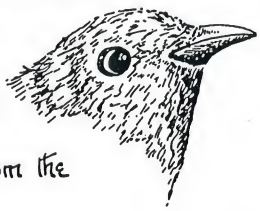
HOOPOE

Diet consists chiefly of insects, as well as other small animal life
The Hoopoe spends much of its time digging in the ground with its long hard beak, in search of insects.

GREAT TIT

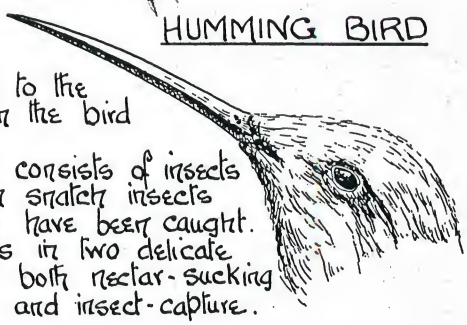
The bill is very short and strong.
The food consists chiefly of insects and other small animal life.
Most destructive in its liking for tree buds and fruits like apple and pear.

CUCKOO



A very useful bird in that it feeds on troublesome insects and their caterpillars, particularly the hairy ones.
The stomach is often lined with the hairs from the bodies of its victims

HUMMING BIRD



The long slender bill shows perfect adaptation to the type of flower from which the bird gets its nectar.
Much of its food consists of insects and spiders. It will even snatch insects from the web after they have been caught.
The tongue which ends in two delicate brushes is suitable for both nectar-sucking and insect-capture.

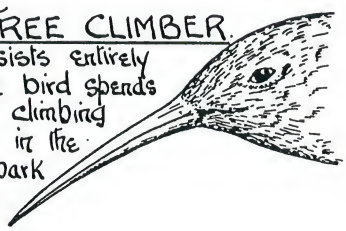
COURSER

The long curved beak is admirably suited to obtain its food of insects, which are caught on the wing

SWALLOW.

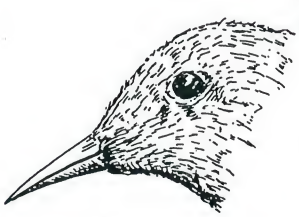
Like the swift, the swallow possesses a very small bill, and captures its food of small insects on the wing.

TREE CLIMBER.



The diet here consists entirely of insects, and the bird spends most of its time climbing trees and looking in the crevices of the bark for its food.

DIPPER



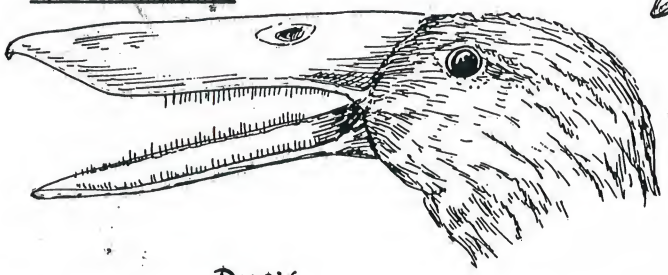
An inhabitant of the shore, this bird dives for its food of water insects.
In addition, the Dipper devours shell-fish.

M.W.M.J.

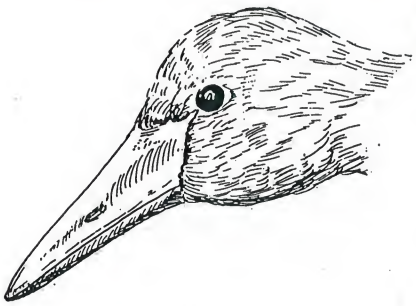
54 BIRDS. OMNIVOROUS (Mixed diet of animal and vegetable life)

The Shoveller feeds upon grasses, worms, slugs, snails, insects and small crustaceans.
The ugly bill is a very well adapted sifting organ, being provided with bristle-like structures which retain all edible material as the mud is squeezed through the bill.

SHOVELLER.



WHOOPER SWAN

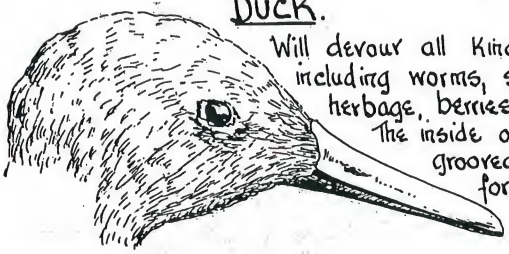


Food consists of water plants, grass, small aquatic life, and grain.

SPOONBILL.

A wading bird which feeds upon smaller creatures than does the Heron. Its diet also includes vegetable matter and offal.
It works its flat bill to and fro in the water, in order to obtain its food.

DUCK.

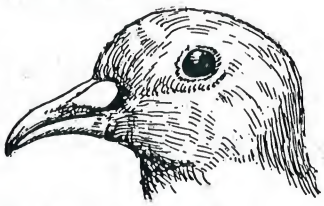


Will devour all kinds of food including worms, small aquatic animals, herbage, berries, acorns and grain.
The inside of the bill is deeply grooved, and is well adapted for sifting the mud, and cropping the vegetation.

GOOSE

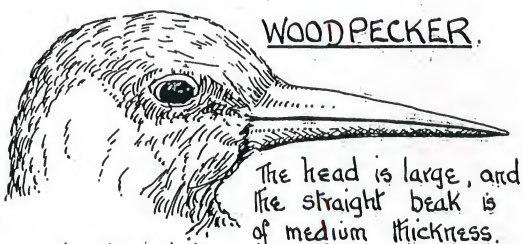
Purely vegetarian diet includes grasses and marine vegetation. Its liking for grain makes it destructive.

PIGEON.



The beak is soft at the base. Animal diet consists of snails and other small creatures, while the vegetable food includes herbage, seed and grain

WOODPECKER.



The head is large, and the straight beak is of medium thickness.
It is partial to a diet of nuts and berries, as well as to wood-boring insects, which it easily picks out with its pointed beak
In the insect-eating woodpeckers the tongue bears spines
In the sap-sucking types, the tongue ends in a brush.

STARLING.

Eats almost anything, but works particulary for worms, insects etc. by parting the grass with its long beak. Will also catch insects on the wing, and devour carrion. Frequently climbs trees.

HOUSE SPARROW.

Strong seed-cracking beak. Nips insects from the leaves and in the air. Very partial to moths.

CHAFFINCH

Feeds on insects, buds, and seeded fruits such as Blackberry.

MISSEL THRUSH

Particularly partial to Mistletoe berries and snails

M.W.M.J.

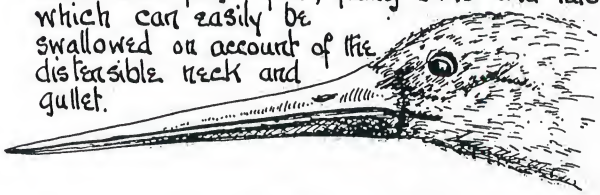
BIRDS. OMNIVOROUS (Mixed diet of animal and vegetable life)

FLAMINGO

A large wading bird with webbed feet, supporting it in the mud. Food consists of small life, in or at the surface of the mud. The beak is used with a backward action, so that the upper mandible is below the under. The animal matter so scooped is therefore easily captured.

HERON.

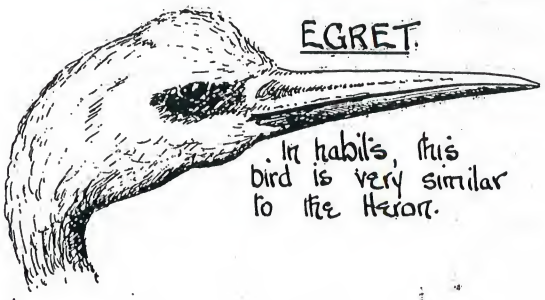
A wading bird which can also swim. Eats frogs, fish, young birds and rats etc, which can easily be swallowed on account of the distensible neck and gullet.



PLOVER.

A shore bird, feeding on insects, worms and grubs, as well as ground berries.

EGRET.



In habits, this bird is very similar to the Heron.

PETREL

Feeds on marine organisms. Very partial to scraps of food particularly of an oily or fatty nature. Some of the larger species are reputed to devour the smaller.

PELICAN.

This bird feeds chiefly on fish which it can store in numbers within the pouch, formed by the lower portion of the beak. The food so stored may be eaten at leisure or carried to the developing young.

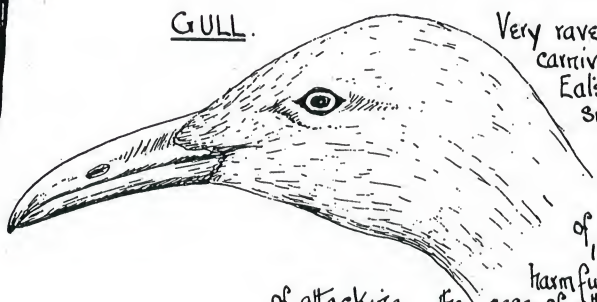
COMMON CRANE

Although a marsh bird the crane is not a fisher. It lives on small animals, grain, and green vegetable food.

AUSTRALIAN IBIS.

The Ibis is a wading bird related to the spoonbills, and resembling them in its feeding habits.

GULL.

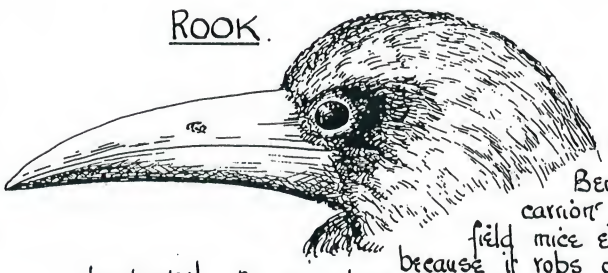


Very ravenous and often carnivorous bird. Eats insects, worms, small fish etc. Benificial as a scavenger and destroyer of injurious insects, it is particularly harmful in its habit of attacking the eggs of other sea fowl.

STORK.

A wading bird, very fond of small animal life and offal. It is very partial to Lizards, snakes, slugs, young birds, small mammals and insects.

ROOK.

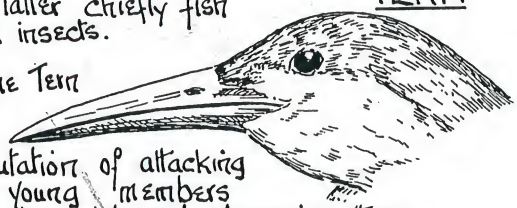


Beneficial in devouring carrion, destructive insects, field mice etc. It is harmful because it robs other nests, and is also partial to succulent fruits like cherries, as well as to grain and walnuts.

M.W.M.J.

56 BIRDS. DIET OF FISH

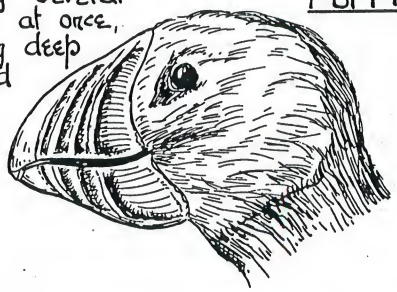
TERN



Food consists of carrion and animal matter the latter chiefly fish and insects.

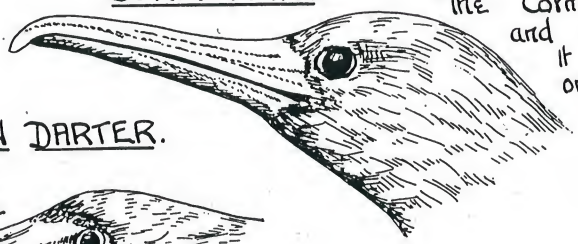
The Tern has the reputation of attacking the young members of its kind and devouring them.

PUFFIN



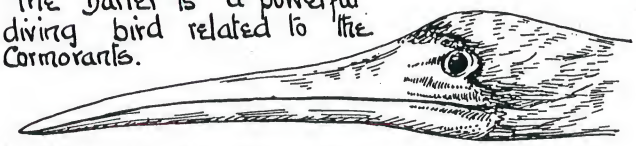
A diving bird similar to the Auks and Razorbills. Unlike them, however, it has the Power of carrying several fish in its beak at once, each time biting deep into the fish and so preventing its escape.

CORMORANT.



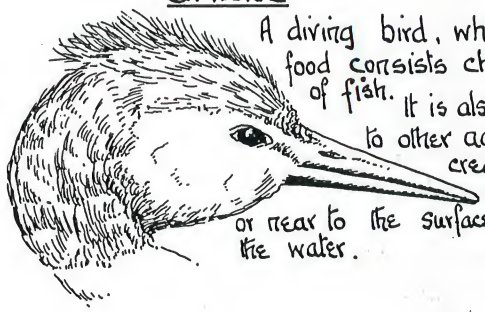
The Cormorant swims low in the water, and dives with great power and agility. It feeds on fish, frequently large ones, which it can gorge with great rapidity

AMERICAN DARTER.



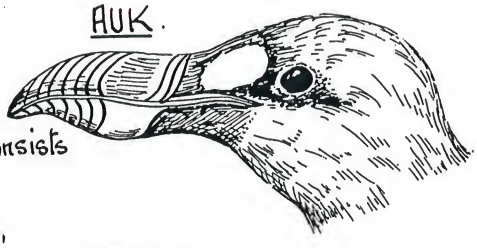
The Darter is a powerful diving bird related to the Cormorants.

GREBE



A diving bird, whose food consists chiefly of fish. It is also partial to other aquatic creatures found at or near to the surface of the water.

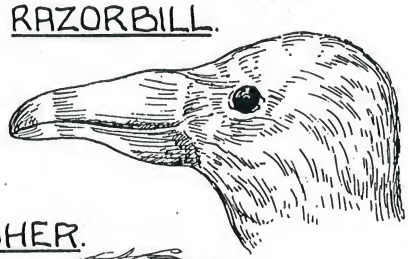
AUK.



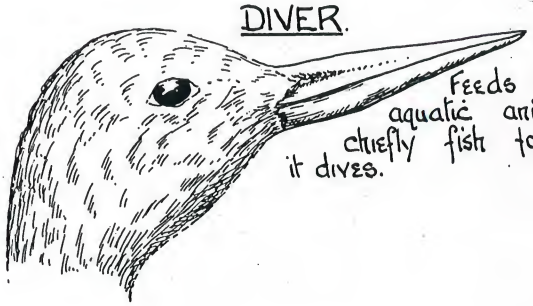
Auks and Razorbills are similar in that they dive for their marine food, which consists chiefly of fish.

Unlike the puffins, the Auks and Razorbills can carry only one fish in the bill at one time

RAZORBILL.

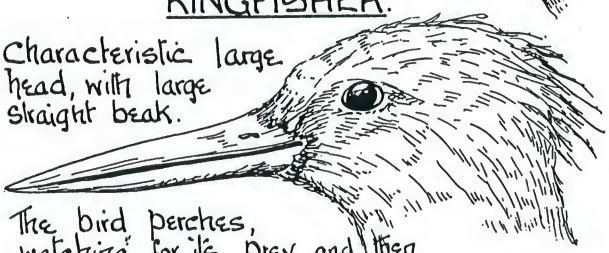


DIVER.



Feeds on aquatic animals, chiefly fish for which it dives.

KINGFISHER.

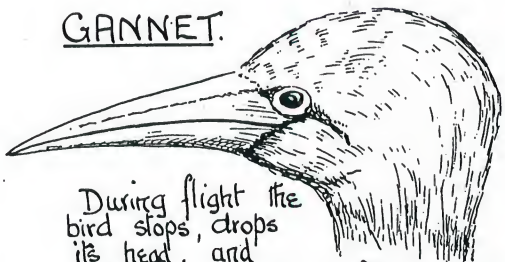


Characteristic large head, with large straight beak.

The bird perches, watching for its prey, and then darts for, and swallows it whole.

Food consists chiefly of fish, and other aquatic animals.

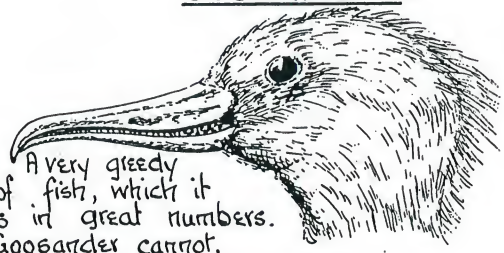
GANNET.



During flight the bird stops, drops its head, and suddenly dives for a fish, which is rapidly swallowed

Immediately after this, the bird takes wing again.

GOOSANDER.



A very greedy eater of fish, which it devours in great numbers. The Goosander cannot, however, tackle very large fish.

M.W.M.T.

BIRDS. VARIOUS TYPES OF FEET.

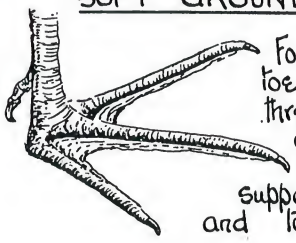
The feet of Birds, like their beaks, show every adaptation to the habitat and mode of life of the Bird.

Apart from walking, swimming, perching and climbing, the feet often aid the beak in the catching and devouring of food.

BIRDS OF PREY. e.g. OWL.

The toes are arranged in pairs, the fourth being directed backwards beside the first, so forming an effective weapon for catching, crushing, and carrying its victims. The talons are sharp and powerful tearing organs. These characteristics, coupled with the hooked beak, are found in all birds of prey.

SOFT GROUND. e.g. CURLEW.



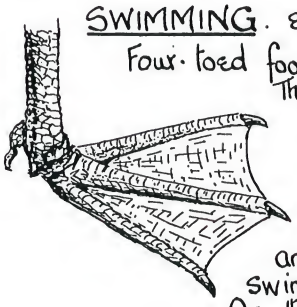
Four-toed foot. Hind toe very small. The three remaining toes are spread out to form a substantial support, to take off from, and to alight on to soft surfaces.

PERCHING e.g. KINGFISHER

Four-toed bird. Hind toe directed backwards, while the three remaining toes are directed forwards, and joined in front for some part of their length.

This foot is an example of the Syndactyl type.

SWIMMING. e.g. DUCK.



Four-toed foot. Hind toe useless. The three toes are fully webbed, a tough membrane being stretched between them. The foot serves as an effective paddle when swimming

On the other hand the Duck is an ungainly walker.

In Cormorants all four toes are webbed.

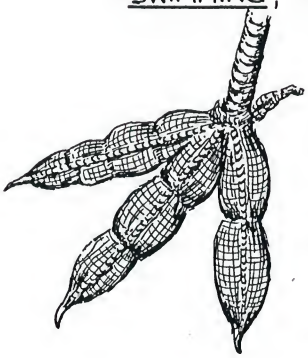
RUNNING e.g. PHEASANT.

Similar to the feet of other game birds and fowls. The shanks are strong, the feet powerful, while the blunt claws are especially adapted to scratching the ground in search of food. The hind toe is very small.

This form of foot is described as the Anisodactyl type.

SWIMMING, WALKING AND RUNNING.

e.g. COOT.



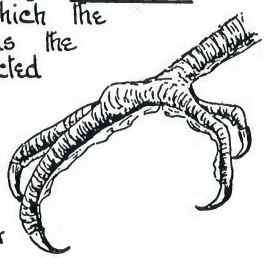
This foot is adapted equally well for swimming, walking and running.

The hind toe is small, while the three front toes are not webbed jointly, but each toe is provided with a scalloped fringe of skin

Thus each toe is webbed separately for swimming.

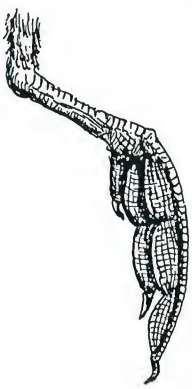
They are all free to enable the animal to walk easily, and they are widespread to distribute the weight of the body evenly when the bird is walking over boggy areas.

CLIMBING e.g. PARROT.



Zygodactyl type in which the paired toed foot, has the 1st and 4th toes directed backwards, and the 2nd and 3rd toes forwards when perching.

In addition the feet are used for climbing and eating purposes.



Folded position of the foot, where the toes lie behind each other.

Thus in the forward stroke through the water, the foot offers little resistance.

M.W.M.J.

INDEX